Collaborative electronic purchasing within an SME consortium

Vogt, Oliver

Durham University

School of Engineering

COLLABORATIVE ELECTRONIC PURCHASING WITHIN AN SME CONSORTIUM

By Oliver Vogt

PhD Thesis, November 2008

Collaborative electronic purchasing within an SME consortium

by Oliver Vogt

Abstract

The main function of purchasing is to assure the supply with required goods and services. Large organisations have both finances and knowledge to implement optimised purchasing resources, typically using information and communications technology (ICT) to improve efficiency. On the contrary, within individual small and medium sized enterprises electronic purchasing is conducted predominately through supplier's sales web sites.

This problem domain has not been addressed by researchers extensively in the past. In this thesis we analyse the requirements and characteristics of small and medium enterprises (SME), and thus propose a novel process framework which allows several organisations to collaborate in purchasing, thereby achieve economy of scale supported by ICT to level large enterprises. The framework adopts new features; it enables cross-sector collaboration for different types of organisations; it addresses the development of the purchasing function for small organisations; and it also includes process issues such as trust and commitment.

The framework has been implemented and explored using a real-world case study and action research approach. Collaborating electronic procurement prototype software has been used to support the piloting phase. It was found that the use of the framework does stimulate and support SME collaboration in purchasing with the

following beneficial results: financial savings for individual participating organisations, inner-consortium trust and inter-organisation communication, and expansion towards other areas of collaboration. As a result of these findings a further model of how to develop a collaborative consortium was introduced. However, only geographically proximate organisations were considered and the use of the results may be unsuitable even when gain distribution is questioned. This research focuses on establishing collaborative processes; exact financial cost comparison models require further research and available primary data. The major strengths of the results are thus: the stimulation of new consortia; the achievement of economy of scale, and the ability to rival large organisations in efficiency of purchasing by means of electronic collaboration.

Declaration

This research contains no material that has been accepted for the award of any other degree or diploma in any university.

To the best of my knowledge and belief this research contains no material previously published by any other person except where due acknowledgement has been made.

Signature: Oliver Vogl

Date: 28/11/08

Acknowledgements

I wish to express my thanks to my first supervisor Prof. Paul G. Maropoulos. I am very grateful to my supervisors, Professor Keith Bennett and Professor Val Vitanov, who inspired and encouraged me during the process of writing up. This thesis could not have been completed without the help, suggestions, guidance, patience and wisdom they have given to me whilst preparing this thesis.

The industrial perspective is very important in this thesis: I am indebted to the contributions made by various individuals of the main industrial sponsor. Thanks to all the members and the Derwentside Engineering Forum staff for the support and thoughtfulness during the preparation of this thesis. Also, this project would not have been possible without the financial support of the Engineering and Physical Sciences Research Council (EPSRC), UK.

I owe a debt of gratitude to a number of people who helped supported and encouraged me during my candidature for this degree. Thanks to family and friends that have supported me. It has been a long and exciting journey.

The first PhD is the most difficult...

Thank You All!

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

ADSL: Asymmetric Digital Subscriber Line

Agility is the ability to respond quickly to changes in customer or competitive demands (Christopher 2000).

BPR: business process re-engineering

Coherence can be understood as "the holding together to form a whole" (Oxford 2000).

Collaboration is defined as "a process of several organisations working together in synergy, executing common business activities to achieve a common goal by pooling resources" (Collins 2000).

Commitment is an engagement or obligation that restricts freedom of action (COED 2005).

A **competitive advantage** can be defined as the unique blend of activities, assets, relationships, history, and market conditions that an organisation exploits in order to differentiate itself from its competitors and to create value to customers (Porter 1985).

A **consortium** is defined as "an association of organizations or states formed for commercial or financial purposes" (SOED 2002).

CAD: Computer-aided Design

CAM: Computer-aided. Manufacturing

CBI: Confederation of British Industry

CPFR: Collaborative Planning Forecasting and Replenishment

CPM: Competence Profiling Methodology

Culture refers to 'the way things are done in our company' (Stannack 2003).

DEF: Derwentside Engineering Forum

DIY: Do-It-Yourself

EDI: Electronic Data Interchange

Electronic Procurement: Conducting procurement supported by computer systems (mostly through the Internet) enables organisations and buyers to acquire products and services, and is called electronic procurement or e-procurement (Boer 2002, Davila 2003, Dolmetsch 1999).

Enterprise resource planning (ERP) is an industry term for the broad set of activities supported by multi-module application software that help a manufacturer or other businesses manage the important parts of its business: product planning, parts purchasing, maintaining inventories, interacting with suppliers, providing customer service, and tracking orders (Software AG 2005).

E-Procurement: see Electronic Procurement

A **framework** is defined as a set of ideas or rules that is used as the basis for making judgements and decisions (Oxford 2000).

ERP: see Enterprise Resource Planning

HTML: Hypertext Markup Language

ICT: Information and Communications Technology

IOIS: Inter-organisation Information System

IPR: Intellectual Property Rights

ISO: International Organization for Standardization

JIT: Just-in-time manufacturing

KPI: Key Performance Indicator

Management is the act of controlling and directing a business.

Metrics are measures to indicate progress or achievement.

MRO: Maintenance Repair and Operation goods

MRP: Materials Requirements Planning

MRP II: Manufacturing Resource Planning

A **network** is defined as a collection of relationships that binds a group of independent organizations together (Das 1998, Gulati 1995).

NIGP: National Institute of Governmental Purchasing

NPD: New Product Development

OEM: Original Equipment Manufacturer

ORM: Operating Resource Management

OPP: Order Penetration Point

PDF: Portable Document Format

PLM: product lifecycle management

Purchasing is defined in the NGIP (NIGP 1996) dictionary of purchasing terms as "the act and the function of responsibility for the acquisition of equipments, materials, supplies and services". Purchasing describes determining the need, selecting the supplier, arriving at a fair and responsible price and terms, preparing the contract or purchasing order, and following up to ensure timely delivery" (NIGP 1996).

Procurement is defined in the NGIP dictionary of purchasing terms as "the combined functions of purchasing, inventory control, traffic and transportation, receiving and inspection, storekeeping, salvage and disposal operations" (NIGP 1996). For the purposes of this research, purchasing is the competition of a simple 'buying' transaction with a supplier, whereas procurement involves a complex chain of activities, including product selection.

A **purchasing consortium** (Hendrick 1997) is defined as a group of "organisations that join together, either formally or informally, or through an independent third party, for the purpose of combining their individual requirements for purchased materials, services, and capital goods to leverage more value-added pricing, service, and technology from their external suppliers than could be obtained if each firm purchased goods and services alone.

Quality can be defined as the total of features and characteristics of a product or service that affect its ability to satisfy a given need (ANSI, Crosby 1979).

R&D: research & development

RFQ: Request for Quotation

ROI: return on investment

SSL: Secure Socket Layer

SCOR: Supply Chain Operations Reference-model

SCM: see Supply Chain Management

SME: Small and Medium-Sized Enterprise or Small and Medium enterprises

SLA: Service Level Agreement

Supply Chain Management (SCM) encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. It includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. Supply Chain Management integrates supply and demand management within and across companies' boundaries and relationships. Supply Chain Management is an integration function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performance business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology (CSCPM 2003).

Standardisation is the process of agreeing and adopting generic specifications and controlling variety (Lonergan 2003).

Strategy relates to how a company intends to realise their business goals on a long-term basis (COED 2005). The purpose of a corporate strategy is to integrate an organisation's major goals, policies and action sequences into a cohesive goal (Quinn 1980).

SWOT: strengths, weaknesses, opportunities, threats

Synergy is an interaction or cooperation of two or more organizations to produce a combined effect greater than the sum of their individual capabilities.

T&C: Terms & Conditions

TQM: Total Quality Management

Trust can be seen as one party's confidence that the other party in the exchange relationship will fulfil its promises and commitments and will not exploit other partners' vulnerabilities (Dyer 2000).

Value chain can be defined as the sequential set of primary and support activities that an enterprise performs to turn inputs into value-added outputs for its external customers.

VMI: Vendor Managed Inventory

VPN: Virtual Private Network

WIP: Work in Progress

Workflow is considered as a combination of mostly ICT embedded states and transitions making up a business process that includes procedural steps, people involved, required input and output and tools needed for each step.

XML: eXtensible Markup Language

1. INTRODUCTION

In the past, SMEs were not a focus of comprehensive studies in the research field of procurement and supply management (Aksoy & Derbez 2003, Morrissey & Pittaway 2004, Saunders 1997, Smith & Buddress 2005). Hence, suitable guidelines for the procurement function, inter-organisation information systems and their implementation up to a detailed explanation of the software development process from a practitioner's point of view are lacking. The research project entitled 'Collaborative electronic purchasing within an SME consortium' involves the sharing of an electronic purchasing system within a group of companies, an initiative that would be cost prohibitive to companies on an individual basis.

This research will give a systematic state of the art overview and develop a set of rules and ideas for forming a framework for manufacturing SMEs on how to approach inter-organisation collaboration by developing a consortium for electronic procurement.

This chapter explains the business context and the industrial need for this research; a structured approach on how to address this throughout this thesis is presented.

1.1 Business context for electronic procurement of SMEs

With the advent of the Internet, many advances in the field of procurement have been made possible. Conducting procurement supported by computer systems (mostly through the Internet) enables organisations and buyers to acquire products and services, and is called electronic procurement or e-procurement (Boer et al. 2002, Davila et al. 2003, Dolmetsch 1999). An electronic procurement application is a software tool that enables organisations to automate non-value-added purchasing tasks and allow supply chain professionals to focus on the strategic analysis (Allen 2003). Common practice of electronic procurement within SMEs is predominantly based on supplier's web site solutions (Attaran 2001, Batenburg 2007, Chau 2003, Deeter-Schmelz et al. 2001), which is sell-side driven. However, this thesis researches supply side collaboration, the buyer side of electronic procurement.

In essence, the purposes of electronic procurement are: (a) to streamline and automate routine processes, (b) to enlarge the supplier base and (c) to consolidate purchasing workflow processes - in other words to lower cost, improve efficiency and control the process (Carter et al. 2000, Dolmetsch 1999, Hughes 2002, Parida & Parida 2003, Wyld 2004).

The term purchasing is associated with acquiring something by payment (Dictionary 2007), whereas procurement is considered as the process of obtaining supplies (Oxford 2000). In practice, the terms 'purchasing' and 'procurement' are often used as synonyms (CSCMP 2003) and finding a common accepted definition is difficult (Jeeva 2004). In this research purchasing is considered with a narrower focus than procurement (Eyholzer 2002, MacManus 2002, Parida & Parida 2003).

Purchasing is defined in the US National Institute of Governmental Purchasing (NIGP) dictionary of purchasing terms as "the act and the function of responsibility for the acquisition of equipments, materials, supplies and services" (NIGP 1996). Purchasing describes determining the need, selecting the supplier, arriving at a fair and responsible price and terms, preparing the contract or purchasing order, and following up to ensure timely delivery.

Procurement is defined in the NIGP dictionary of purchasing terms as "the combined functions of purchasing, inventory control, traffic and transportation, receiving and inspection, storekeeping, salvage and disposal operations" (NIGP 1996). For the purposes of this research, purchasing is the completion of a simple buying process with a supplier, whereas procurement involves a more complex chain of activities, including product selection.

Figure 1 provides an overview of the procurement function of an SME, which will be discussed throughout this thesis. Procurement has a generic process (see Chapter Four), which is part of the overall business workflow. Within this research, a workflow is considered a collection of cooperating, coordinated activities designed to carry out a well-defined complex process (Davulcu et al. 1998), that includes procedural steps, people involved, required input and output and tools needed for each step. Also important in this context is the term value chain, which can be defined as the sequential set of primary and support activities that an enterprise performs to turn inputs into value-added outputs for its external customers (Kaplinsky & Morris 2001, Sturgeon 2001). Overall and procurement workflow should support strategic priorities within the value chain of a company. In essence, procurement activities will be related to technical specifications, commercial activities such as payments, administrative tasks and transportation logistics (Figure 1).

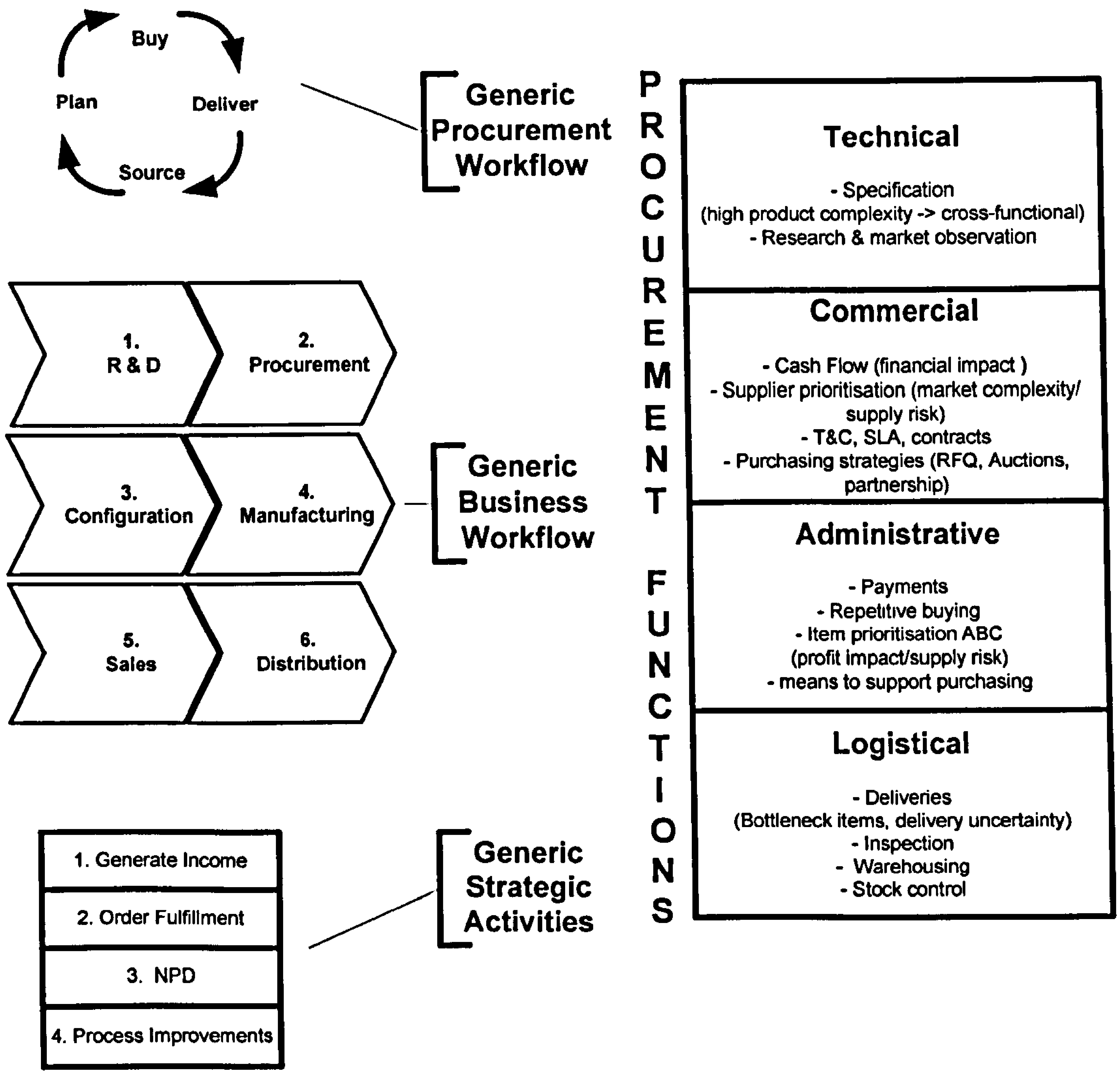


Figure 1: Procurement functions within an SME

The current business structures in Western Europe considered in this thesis were developed after the Second World War; the markets were not yet global. Eastern Europe and South East Asia could not compete, however, in the past due to their political systems, economy structures, lack of knowledge and technology (which was actively enforced by law). The following listing summarises recent changes of the business environment for an SME (Carter et al. 2000, Ogden et al. 2005, Zheng 2007) and the consequences for procurement:

Economic globalisation: The Internet has changed the way SMEs conduct their business with external partners by providing the opportunity to source worldwide (Trent 2003). From a collaborative purchasing perspective, this has two main implications: the cost of purchased goods is influenced by economies of scale represented in differing production costs as well as by economies of scope in transportation. Furthermore, growing local economic areas with increasingly homogenous regulations such as EU, North American Free Trade Agreement (NAFTA), and the 'Yen Bloc' make trade for large number of companies much easier (van Weele 2005).

Advanced ICT: Because of the influence of the Internet, modern ICT also changed the internal procurement workflow. Most Enterprise Resource Planning (ERP) systems include purchasing functionality and have interfaces for data exchange, which is essential for an efficient sales/procurement process.

Customer behaviour: In the past customers mostly considered price and quality of a product. Recent demands include customisation, after-sales service, on-time delivery and upgrade compatibility towards future technologies. Customers consider increasingly the so-called Total Cost of Ownership (TCO) (Degraeve et al. 2005, Ellram 2002). This includes customer exposure of the purchasing department at early project stages.

Organisational structures: Starting with initiatives within the military and automotive industry the procurement process as part of Supply Chain Management (SCM) is considered increasingly important. Accordingly, a strategic component was added to procurement; still, the position is perceived differently depending on the size of the organisation.

Specialisation & outsourcing: In the past, especially many large enterprises had a high "production depth" conducting most of the steps within the value chain inside the company (e.g. Ford). This has changed. Most successful companies concentrate on their core competences, for example, conducting the final assembly and the design of new products. Other tasks are left to specialised suppliers (Heshmati 2003). This principle is also true for SMEs but obviously on another scale (Do et al. 2006), for example, outsourcing ICT or accounting.

SMEs have to respond to these challenges, keep up-to-date with technology and adapt to changing customer behaviour patterns within an increasingly knowledge driven economy. Necessary evaluation of emerging technologies consumes financial and personnel resources or advice from external consultants can be obtained. This will not change the situation that most of the collaboration and supply chain tools were developed to support large companies' multi-tier supply chain scenarios (Aksoy & Derbez 2003, Morrissey & Pittaway 2004, Saunders 1997, Smeltzer 2001a, Smith & Buddress 2005). Emphasis is on strong leadership within the supply chain (Favilla & Fearne 2005)

but from an SME perspective this will put the company under pressure to adapt, strain already tight resources and is very costly.

Every organisation needs to adjust steadily to: (a) changing markets and (b) customer requests in order to be profitable. Hence, important objectives of SMEs for collaboration are (Riemer et al. 2002) the enhancement of the businesses scope by combining special skills, risk & resource sharing to generate innovation and to increase supply chain power through volume aggregation (Anand & Ravi 2003).

1.2 PURCHASING WITHIN SME COLLABORATIVE NETWORKS

In the past predominantly "soft" collaborations were formed, for example, in the form of trade associations with the purpose of identification and approach of common aims based on an informal arrangement. Participants were not directly influencing each other's business success (Sherer 2001). Today the formation of "hard" networks is common practice, where the process of delivering a product or service depends directly on performance and responsiveness of partners within the network. In this context, a network is defined as a collection of relationships that binds a group of independent organizations together (Das & Handfield 1997, Gulati 1995).

A manufacturer will not only be assessed with regard to their own products, processes and capabilities but also those of their suppliers. This is also noticed as a change from "head to head" competition towards competition of supply chains or production networks (Gulati et al. 2000, Poirier 2003, Stock 2000).

Collaboration between SMEs is focussed on gaining a competitive advantage that would be difficult to achieve individually (Sherer 2003). Collaboration is defined as "a process of several organisations working together in synergy, executing common business activities to achieve a common goal by pooling resources" (Collins 2000).

Information and literature on competitive advantage mostly targeting large companies assumes that something distinguishes them from competitors: a product, a process or a combination (Kornelius 1999, Porter 1980, Porter 1985). However, a huge number of small and medium sized manufacturing companies do not have this competitive edge (Christiansen & Maltz 2002).

They offer services at a very competitive price and this is where the collaborative purchasing strategy matters significantly.

Business performance relates much to the utilisation of modern ICT and the inherent process automation. State of the art in industry is the utilisation of ERP systems to coordinate business processes internally (Olsen & Saetre 2007, van Everdingen et al. 2000), but further automated information exchange with suppliers and customers is hardly realised. Technology enabling online real-time collaboration has advanced quickly in the recent years, whereas business context (factors such as customers, suppliers, competitors) and inner-organisational factors (such as business culture) influencing collaborative networks changed more slowly (Batenburg 2007, Levy 2003, van Everdingen et al. 2000).

The right deployment of a purchasing consortium can assure a strategically competitive advantage as many other competitors stand alone with no "knowledgeable" collaboration (Kanter 1994). A consortium is defined as an association of organizations formed for commercial or financial purposes (SOED 2002). Within this research, a purchasing consortium (Hendrick 1997) is defined as a group of "organisations that join together, either formally or informally, or through an independent third party, for the purpose of combining their individual requirements for purchased materials, services, and capital goods to leverage more value-added pricing, service, and technology from their external suppliers than could not be obtained if each firm purchased goods and services alone."

The terms cooperative purchasing, group purchasing, buying offices or pooled purchasing are used in this context depending on industrial branch or nature of collaboration. This indicates that the subject is not yet mature and still under development (Essig 2000, Schotanus 2007). A solid theory for SME collaborative purchasing consortia is still missing (Erridge et al. 2001, Morrissey & Pittaway 2004).

Only 7% of companies participating in a survey (Davila et al. 2003) have adopted collaborative electronic purchasing and, more importantly, only 18% plan an implementation (Huber et al. 2004, Taylor & Murphy 2004). Even after adopting current state of the art e-procurement solution a significant percent of purchases is still managed manually (Minahan 2004).

Collaboration within many organisations increases the difficulties but introduces opportunities such as resource sharing and demand aggregation, too. Especially in the field of procurement, this is due to the huge number and complexity of options and related preferences. Inherent technical and organisational challenges simply outweigh the potential contribution to business objectives (McDonagh & Coghlan 2000).

The scope of procurement activities within SMEs is administrative (Hughes et al. 2004, Quayle 2002, Ramsey 2001) whereas previous academic research in large organizations addresses strategic importance (Cavinato 1999, Nollet et al. 2005, Rich & Hines 1998, Spekman et al. 1994). Nevertheless supply chain collaboration in general is considered as very important (Matchette & Seikel 2004), especially from the perspective of large organisations (Ramsay 1996) and SMEs have to be compliant.

Research in collaborative networks relates inherently to the ability of obtaining access to personnel and resources of participating companies (Gummesson 2000). In the case of managing staff of SMEs the focus is on core competence development and order fulfilment (Chaston et al. 1999, Major et al. 2001). A marketable product or service as a core competence provides an income. Recently the evolution of the purchasing function and its "valued" position within the company has been discussed extensively in academic and practitioner literature but the perceived value in industrial practice is low (Hughes et al. 2004, Ramsey 2001).

SMEs have neither the time nor the resources for supporting long-term research projects in this field. This is another reason why there is only limited research available. Nevertheless, throughout this research the contributions towards business goals and the hierarchical position of the purchasing function within SMEs are analysed.

1.3 Approach of this Research Project

The information presented summarises the results of seven years of work carried out at the University of Durham in partnership with Derwentside Engineering Forum (DEF), a local consortium of 30 small and medium enterprises (SME). The main strategic focus of DEF is the achievement of short-term benefits for member companies and to keep the interest in the long-term collaborative approach high. The research was conducted in parallel with the normal operational work at DEF, which is described as a case study in Chapter Seven.

The subject of this thesis is to research, analyse and develop collaborative electronic purchasing within an SME consortium (Bourner & Simpson 2005). This was approached through breaking down into the following primary deliverables to the industry partner DEF:

- Research: To review academic and industrial state of the art knowledge and practice in procurement, collaborative networking and ICT;
- Business Networking: To develop working relations and establish mutual trust amongst companies and staff involved in the project;
- Short-term Benefits: To deliver immediate benefits to participating companies with the purpose of maintaining a high level interest over the entire project duration;
- Framework Development: To develop a framework for collaborative purchasing (Vogt & Maropoulos 2002);

- Software Development: To develop, test and deploy a collaborative purchasing prototype software (Vogt & Maropoulos 2004).

Together with the industrial partner DEF, it was identified that an intelligent approach to cope with new ICT is a mutual undertaking to develop a collaborative e-procurement hub for members. This hub is an example and test bed for other future e-business research projects, too. For this project in particular, a common "purchasing language" must be found and the purchasing process has to be modelled in accordance with the involvement of core suppliers. This will clarify the requirements for the subsequent development of the hardware and software infrastructure of this research. Finally, the decision had to be made, to purchase software for collaborative purchasing or to self-develop and deploy.

A common problem of industry related research into 'managerial' issues is the fact that experiments cannot be set up within controlled environments but in real life situations (Gummesson 2000, McNiff & Whitehead 2000). Consequently, the research is influenced by many hidden objectives of involved parties. Hence, this research follows a flexible, mainly qualitative research fitting the method to accomplish the objectives (Silverman 2005). Qualitative research is primarily concerned with the "why", the understanding of behavioural patterns underlying the researched processes. Qualitative research derives information from observation, interviews, or verbal interactions and focuses on the meanings and interpretations of the participants (Holloway & Wheeler 1995). Trying out ideas in practice as a means of increasing knowledge about or improving curriculum, teaching, and learning is called action research (Kemmis & McTaggart 1988).

Alongside with the research's inherent advancement of knowledge, action research supports the outreach directly into local business communities (Bourner & Simpson 2005). In addition to many other merely analysing and investigating research theses in procurement (Eyholzer 2002, Kornelius 1999, Rozemeijer 2000, van Stekelenborg 1997), the focus of this research is to contribute to an improvement of the current state of collaborative procurement. Quantitative studies into collaborative purchasing are rare in literature (Schotanus 2007) as they are pre-conditioned to have available purchasing consortia (Doucette 1997, Hendrick 1997, Huber et al. 2004) for data collection.

Within this research, a deliberate solution-oriented investigation towards the development of a purchasing consortium by the author is conducted using the following methods in a combination:

- an extensive literature study –research into state of the art knowledge;
- face-to-face interviews and an online survey – trough 'explanatory' networking and data collection;
- development of several models towards electronic collaboration of SMEs - through assumptions to reduce the complexity of reality in combination with a systematisation;
- provision of an action researcher as a resource to implement changes;
- a case study evaluating results and current industry standards - the way how the research proceeded (Wolcott 2001).

The aim of this thesis is to research how to improve the purchasing function of SMEs by collaborating within a consortium. The development of a procurement framework for SMEs, a model on how to establish collaboration and introduction of collaborative electronic purchasing prototype software are the results of work to date. Figure 2 shows the conceptual structure of this research using the methods above.

In Chapter One background, motivation, objectives and limits of this research are covered. This includes important developments in the field of procurement and business networking of SMEs. The Chapter finishes by defining objectives of this research project and a structural overview of how these issues were addressed.

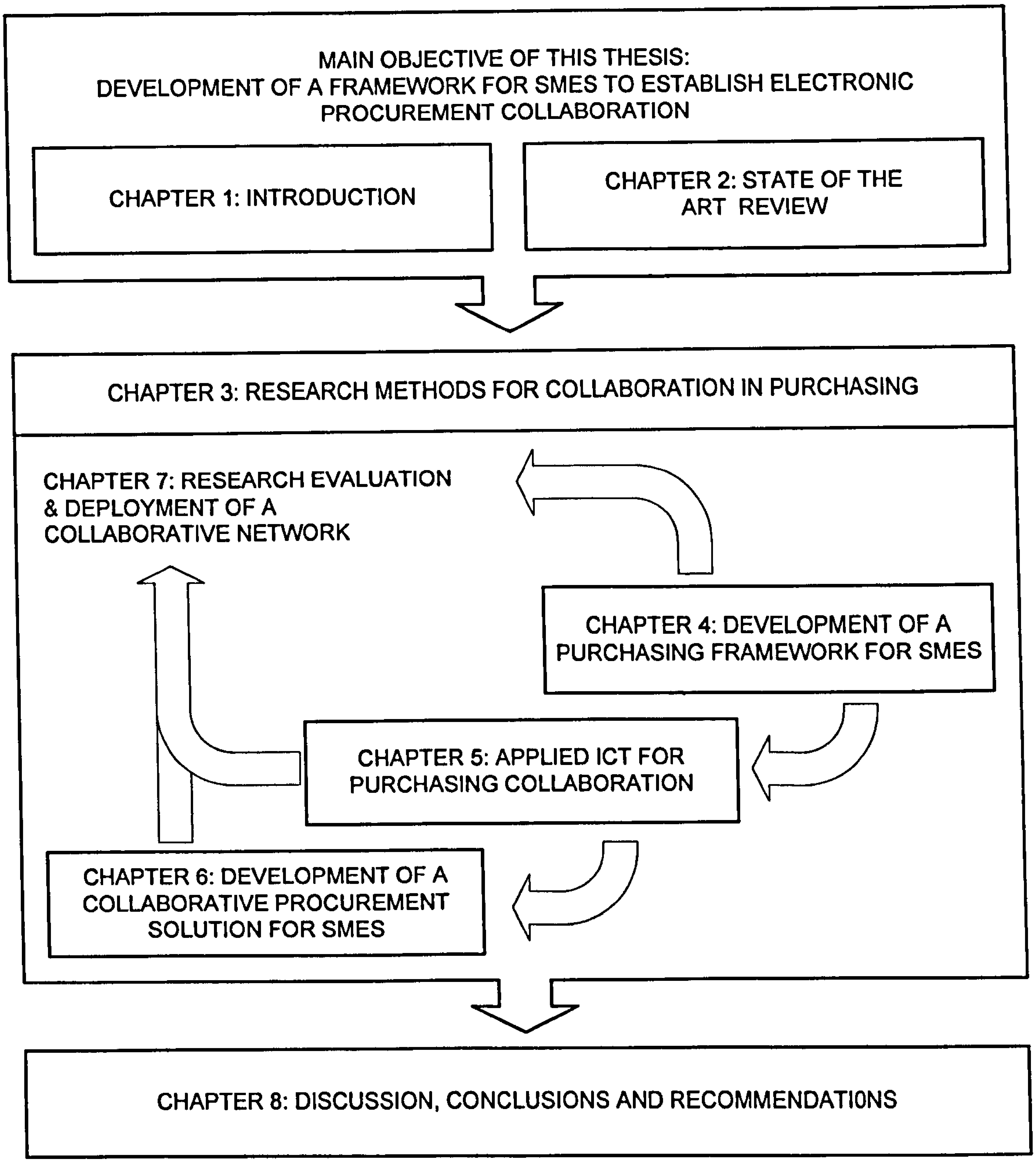


Figure 2: Conceptual structure of this research

Chapter Two gives an overview of state of the art research in relevant areas such as purchasing/procurement, SME collaboration, ICT developments and supply chain management. The chapter follows a top-down approach beginning with a summary of research in collaborative concepts. In particular, opportunities for collaborating companies are considered with their significance for the industry partner consortium DEF as one example. Next, supply chain trends and problems for SMEs are explored, breaking down into tangible business scenarios. A summary of purchasing and procurement trends is also given. An outline of relevant means of ICT and developments concludes the chapter. Chapters One and Two give the necessary background information on how to address the problems outlined in Chapter Seven, the case study of a collaborative consortium. Chapter Two finishes with the formulation of research objectives relevant for the knowledge contribution and application within industry.

Chapter Three describes the research methods applied to approach the research problem and to answer the research objectives developed in Chapter Two.

Chapter Four gives an insight into organisational issues of procurement within SMEs developing a framework. In this context, the term framework is defined as a set of ideas or rules that are used as the basis for making judgements and decisions (Oxford 2000). A top-down approach is chosen looking first into the general business strategy of SMEs followed by relations to the purchasing function. Purpose of the following framework is to advise management, fulfil a much-desired alignment of business strategy with functional strategy, and connecting it to operational methods and tools. Within this thesis the term management is understood as the act of controlling and directing a business. Next, the organisational management and business maturity are related to the execution of purchasing, always under consideration of inter-organisation collaboration. Finally, the chapter investigates into the systematic organisation of the actual purchasing department, namely decision metrics, workflow and supplier issues. The procurement framework leads to the next chapter, which outlines the application of ICT for collaborative electronic purchasing within an SME consortium.

Relevant knowledge for the development of a collaborative inter-organisation ICT solution is explained in Chapter Five. Considering SMEs as independent units in a collaborative network, starting from individual ERP systems, a collaborative electronic purchasing solution is proposed and a collaborative data exchange standard is considered. Finally, this chapter ends with a discussion of security issues for inter-organisation information systems (IOIS).

Prototype software for collaborative purchasing was developed, which is discussed in Chapter Six. In order to meet the requirements of a collaborative community, a purchasing workflow was designed and deployed in the form of a web based collaborative procurement software transforming inter-organisational collaborative intention into execution.

The background of the industry partner consortium DEF is presented in Chapter Seven. The context and environment in which the research was carried out is essential for understanding the results and conclusions. This chapter identifies expectations, motivation and objectives of DEF member organisations and their interference with the objectives of this research. Furthermore, the process of obtaining primary data in the field of purchasing conducting semi-structured interviews is explained constituting a starting point for the development of the collaborative e-procurement prototype software. Based on experiences gained during this research project a model for the development of a collaborative consortium is synthesised from the results of the previous chapters.

Chapter Eight concludes with a summary of the results and recommendations for SMEs with regards to their procurement function and potential inter-organisation collaboration. This is based on more than seven years work experience with a group of independent companies and can be used as a quick-start framework for other SME consortia.

To summarise the structure of this research, an overview of developments in inter-organisation purchasing is given up to a level of influencing the corporate business strategy. This is in parallel with critical remarks and problems within this domain and finalising with results and recommendations for future research. The research in particular contributes with a framework for the development of flexible inter-organisational collaboration within the procurement process for the manufacturing industry. It provides a model, guidelines and recommendation of how to establish a collaborative consortium.

The complexity and breadth of researching organisational and managerial issues of collaboration on purchasing necessitated a mostly explorative and qualitative research approach (McKay & Marshall 2000, Myers 1997). Based on one case study example, the conceptual framework and model of a collaborative purchasing consortium were formulated. Quantitative details on financial impacts or correlations between individual metrics of the framework or model were not yet researched. This thesis contributes toward the development of "how to" models for collaboration purchasing and hence will lay the foundation for quantitative research in this field (Schotanus 2007).

2. STATE OF THE ART REVIEW

In the previous chapter the purpose of this research was explained; from the business context of collaboration in electronic procurement problem statements were derived and an approach to address them throughout this thesis was outlined. This chapter presents a state of the art literature review covering the most important topics for this research project to identify the variables involved in the development of a collaborative purchasing consortium.

First, possibile collaborative networks between SMEs are surveyed. Starting with the needs for collaboration and for co-ordination various network scenarios are investigated. Then directions on how to employ a company's ERP system and an implementation model for new collaborative technologies are presented.

Many times, collaborating companies are situated within a value chain or a production network where supply chain management is used as a coordination tool e.g. applying the Supply Chain Operations Reference model (SCOR) performance attribute metrics (Bolstroff & Rosenbaum 2003, SCC 2004). These performance metrics of many leading companies are available as benchmark data and when correctly used, within the context of an SME, to improve internal business processes the actual aim of SCM can be achieved: the alignment of internal business processes with the corporate strategy (Harland et al. 1999, Knudson 2002, Nollet et al. 2005).

Considering buying and selling as inseparable, within this thesis primarily the procurement function as the input interface is researched. Particular focus is on the alignment of the procurement function of individual companies to achieve collaboration in a steadily changing business environment.

Finally, the latest ICT developments are considered for the development of the customised collaborative electronic procurement solution for a SME consortium.

2.1 COLLABORATION BETWEEN SMEs

There are approximately 19 million SMEs within the European Union (PLS RAMBOLL 2001) and the majority have to compete with non SMEs (multi-nationals and large organisations) for niche markets (Barnes et al. 2004). In the UK, more than 90% of all companies are SMEs, employing more than 55% of the workforce and contributing with just below 45% of the corporate turnover to the wealth (DTI 1998). The European Union (European Commission 2003) defines a Small and Medium Enterprise – SME - as a company with:

- < 250 employees;
- ≤ €50 million turnover (or ≤ €43 million balance sheet total).

In order for an organisation able to cooperate externally it should provide (Eschenbaecher & Zwegers 2002):

- Applications / products / services;
- Business processes;
- People and an organisational structure.

The three main external drivers for the SMEs strategy are (Figure 3): (1) the market in which a company is operating; (2) the products & services a company is offering; and (3) the competitive situation a company is operating (Porter 1980). From an individual company's purchasing perspective, there will be a contract with suppliers, for example, stated in the terms and conditions. There need to be rules and roles for the purchasing process itself and events within the functional process of each organisation to kick-off a purchasing activity such as MRP or internal purchase request.

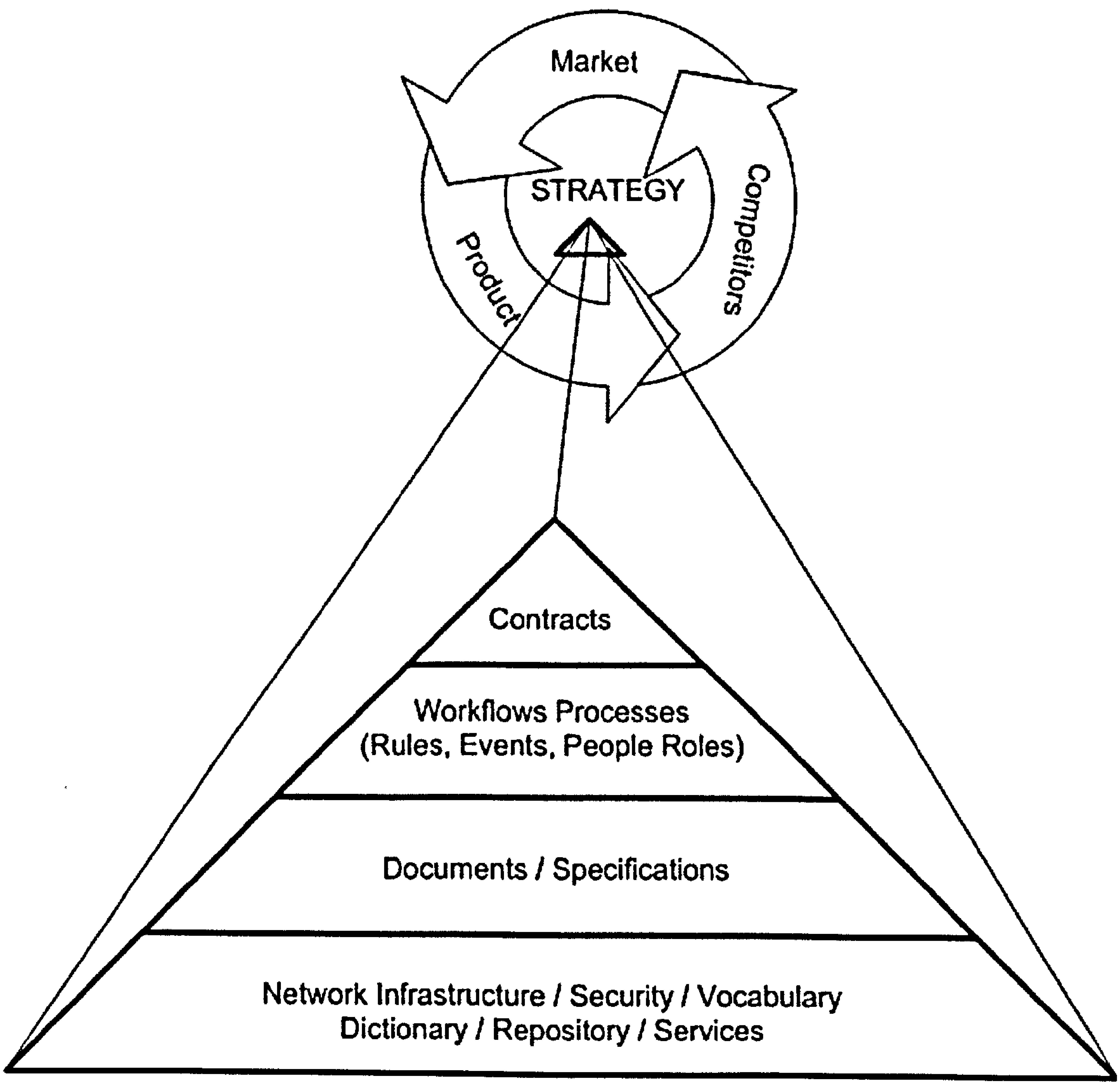


Figure 3: Procurement function in relation to the overall strategy

From the perspective of an individual SME to implement leading edge e-business systems is risky (Minahan 2004, Parida & Parida 2003). Waiting for the technology to mature will reduce technological flaws and price due to economies of scale. Even the latest state of the art technology does not necessarily translate into competitive advantages when publicly available but bears substantial financial risk (Carr 2003); collaboration attenuates this risk while delivering a learn-bed environment.

The driver behind collaboration is generally the need for a partner aimed to gain competitive advantage (Ellram et al. 2002, Harland et al. 1999, Kanter 1994). Each company seeking collaboration is an expression of the current inability to fulfil a task within their own capabilities to meet market requirements and the willingness to share power (and profits). Collaboration and networking (BarNir & Smith 2002) are significant factors of business success and survival (Street 2007). Companies collaborate within a consortium by sharing their core competences (Vanhaverbeke 2001) to provide a superior service to customers.

The relevant interpretation of the term 'competitive advantage' was introduced by Porter (Porter 1985) and further developed by many others (Hamel & Prahalad 1994, Quinn 1992). A competitive advantage can be defined as the unique blend of activities, assets, relationships, history, and market conditions that an organisation exploits in order to differentiate itself from its competitors and to create value to customers (Porter 1985). Inter-firm collaboration is harnessed to reduce the gap between the SMEs competences and market complexity.

The challenge of collaboration (in procurement) between SMEs is the correct alignment of individual business strategies and underlying organisational structures to approach a mutually beneficial goal (Figure 4 and Figure 5). An approach to this problem will be the subject of research throughout this thesis.

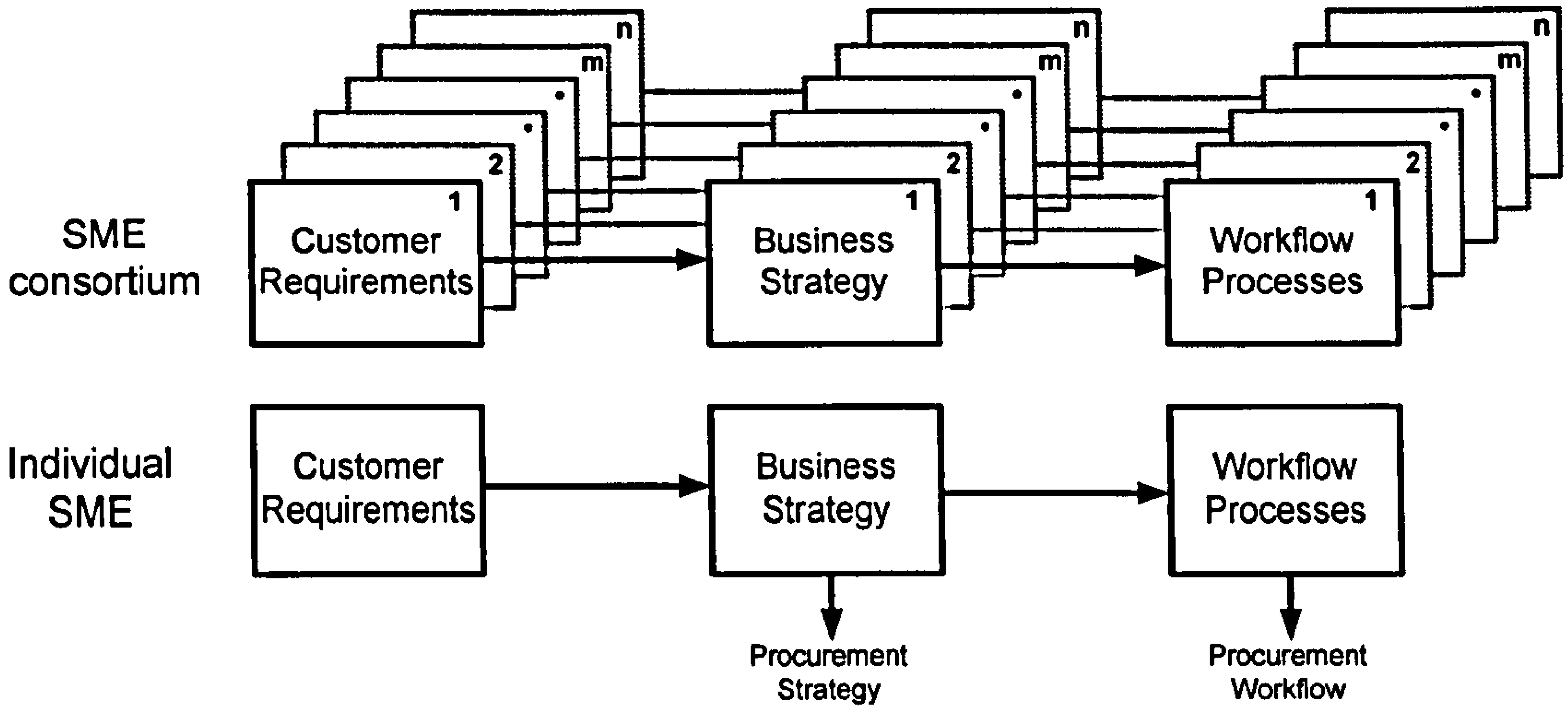


Figure 4: Alignment of corporate strategy and purchasing process for a consortium of SMEs

Within any organisation responsibilities are assigned to employees after the principle of 'division of labour', communication rules are created and policies and management hierarchies introduced to co-ordinate activities (Figure 3 and Figure 5). In a rapidly changing environment, organisational structure and strategy must be reviewed regularly; hence, the journey is the reward. Pre-requisites of collaboration are:

- contractual agreements (such as Terms and Conditions);
- agreements on workflows (for example, responsibilities of individuals);
- common terminology;
- process documentation;
- underlying ICT infrastructure resulting in quality supplier performance (Carter & Miller 1989).

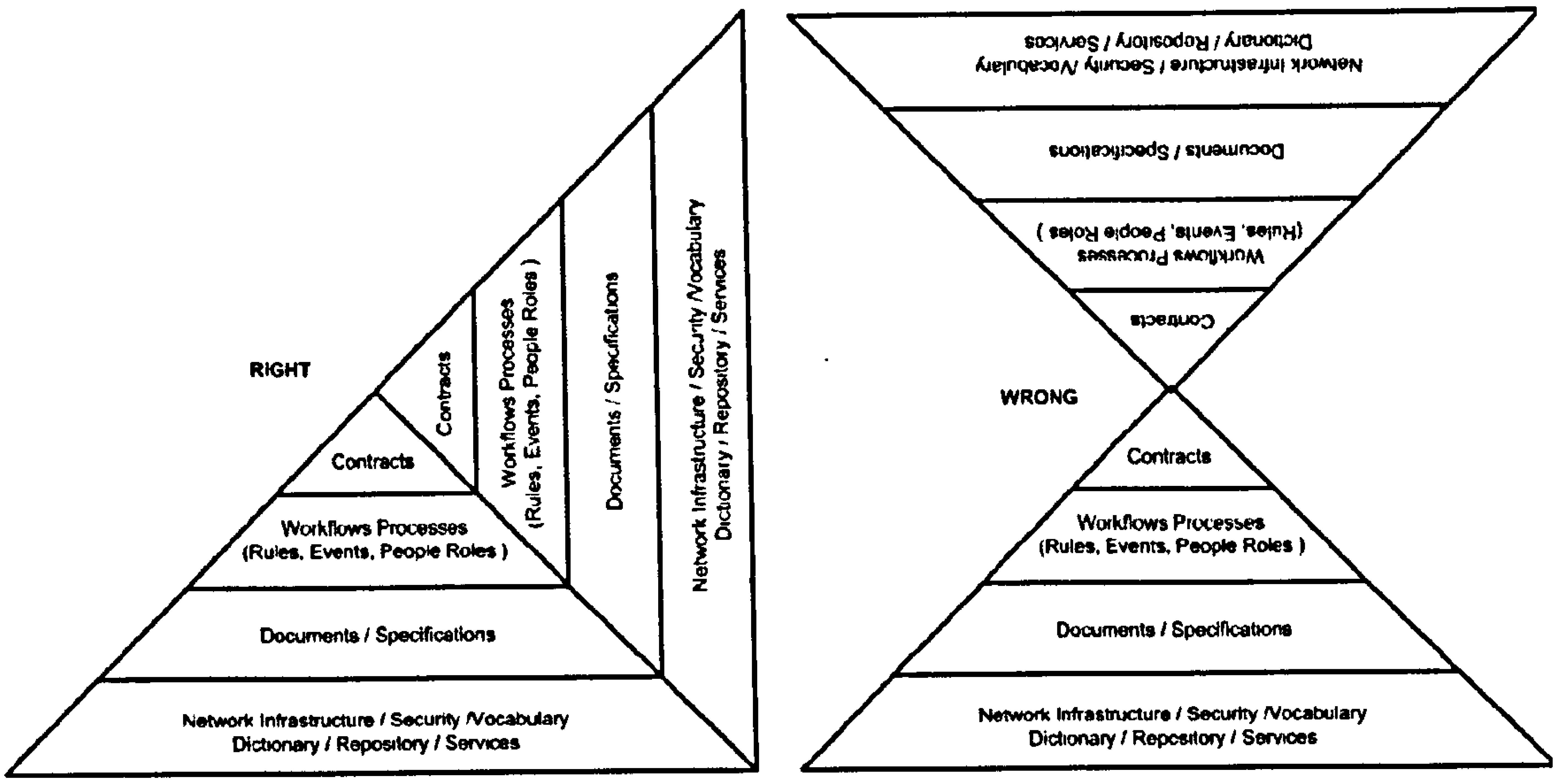


Figure 5: Inter organisation alignment of the procurement function

Collaboration can create synergy (Bititci et al. 2007), which here denotes an interaction or cooperation of two or more organizations to produce a combined effect greater than the sum of their individual capabilities. Synergy does not emerge automatically without the following: (1) commitment, (2) management and (3) trust. From an organisational point of view, trust and commitment are the most important factors in collaboration (Doucette 1997). Commitment is an engagement or obligation that restricts freedom of action (COED 2005). Commitment of member companies with regards to a consortium is shown when internal activities are delayed and collaborative work is prioritised. This is necessary for all inter-organisational collaborative business processes of a consortium (see Chapter Seven).

Trust can be seen as one party's confidence that the other party in the exchange relationship will fulfil its promises and commitments and will not exploit other partners' vulnerabilities (Dyer 2000). Trust is a basis for knowledge and asset sharing which usually leads in turn to lower transaction costs between companies. All costs related to conducting a networked business can be considered as transaction costs (Gilmore et al.

2001), namely partner search, contracting, monitoring or conflict resolution. A low level of trust requires more formal contractual agreed structures (Figure 5) for collaboration (Johanson & Mattson 1987, Varamaki 1996). Many SMEs do not have time and resources to initiate or maintain these to the level necessary for collaboration (Vanhaverbeke 2001).

Roles of individual employees in SMEs are increasingly cross functional (Cooper 2007, DeRuntz & Turner 2003), whereas larger organisations have the resources to employ specialists in fields such as research & development (R&D), business process re-engineering (BPR) and ICT (Levy et al. 2001). Employee flexibility and multiple work tasks are common practise within small companies due to the decreased availability of full-time equivalents. Cross functionality can sometimes be viewed as an asset within smaller organisations (Abdul-Nour et al. 1999). Responsiveness to customer demand tends to be performed with greater efficiency in SMEs compared with their non-SME counterparts. SMEs can become more competitive by teaming up with appropriate partners to share resources such as software, hardware and specialist expertise (Chapman et al. 2000).

In the light of continuing changes in manufacturing process and the trend towards outsourcing services (Do et al. 2006, Heshmati 2003), collaborating SMEs will require proprietary knowledge to enable a regular update of their supply chain. The capability of a company to be a good collaborative partner will become a key asset in the future – a collaborative advantage (Kanter 1994). These circumstances are coupled with a departure from a functionally based corporate structure and modus operandi towards one based on cross-functional teams (Mosey 2005, Webber 2002), agility (Bessant et al. 2003), customer responsiveness (Storey et al. 2005) and mass customisation (Da Silveira et al. 2001, Svensson & Barfod 2002). In this context, agility can be seen as the ability to respond quickly to changes in customer or competitive demands (Christopher 2000).

Hence, collaborations are steadily evolving "systems"; objectives of individual partners might change over time or might never have been revealed completely, which makes the management a considerable effort (Das & Teng 1998, Gilmore et al. 2001).

A common ICT infrastructure (Hoffmann & Schlosser 2001, Levy et al. 2001) to exchange information efficiently will be a pre-requisite and foundation for successful collaboration, whereas the actual objective will be either resource (Grant 1991), or market based. A resource based collaboration will, for example, share R&D costs, allow partners to access core competences or aggregate individual procurement demands. A market based collaboration (Riemer et al. 2002) aims to (a) overcome entrance barriers to new markets, (b) dominate entire markets (which will not be relevant for SMEs most of the time) or (c) develop new markets jointly. Examples for both types of collaboration are discussed in Chapter Seven.

The following basic structures for possible organisational formations and relationships can be distinguished (Podolny & Page 1998, Riemer et al. 2002, Stock 2000):

- Markets;
- Networks;
- Hierarchies.

Leading organisations such as Daimler Chrysler or Airbus impose their de-facto standards for hierarchies representing the value creation process. The strength of these hierarchical organisations is commitment and authorisation to respond quickly (Jeeva 2004).

In contrast, within particular markets, organisations offer their products and services to others. Here, spontaneous collaboration occurs in the form of a free exchange of goods and services, which is typical for free markets (Thorelli 1986).

Collaborating companies usually form a network (Wiendahl & Lutz 2002), which is characterised by relations (structure) and interactions (processes) between a defined set of independent companies aiming to achieve a common goal. Networks introduce co-ordination between independent organisations (Thorelli 1986). A network creates interdependency between autonomous organisations joining the benefits of free markets and hierarchical organisations. Flexibility and independence are high (Danilovic & Winroth 2005).

Most of the scenarios involving SMEs in purchasing collaboration can be considered as networks. This interaction of companies in an open collaborative way will lead to increasing complexity in structure and behaviour of supply chains (Tang et al. 2004). On the other hand, collaboration amongst specialised SMEs allows access to resources of the group and maintain the individual independence, which is beneficial for flexibility, agility, responsiveness and competitiveness (Maropoulos et al. 2004). This structure has advantages (Levy et al. 2001) over big enterprises created through mergers or takeovers, but managing the inter-organisational coherence of involved SMEs is the major task. Coherence can be understood as the holding together to form a whole (Oxford 2000).

Realistically, most companies have suppliers enabling them to sell a product or service to customers. They form a collection of relationships that binds a group of independent organizations together (Das & Teng 1998, Gulati et al. 2000), which can be modelled by considering the following types of relation:

- Hierarchy (Kornelius 1999, Thorelli 1986): is controlled by a strong lead company. This includes the information and product up and down stream (Figure 6).

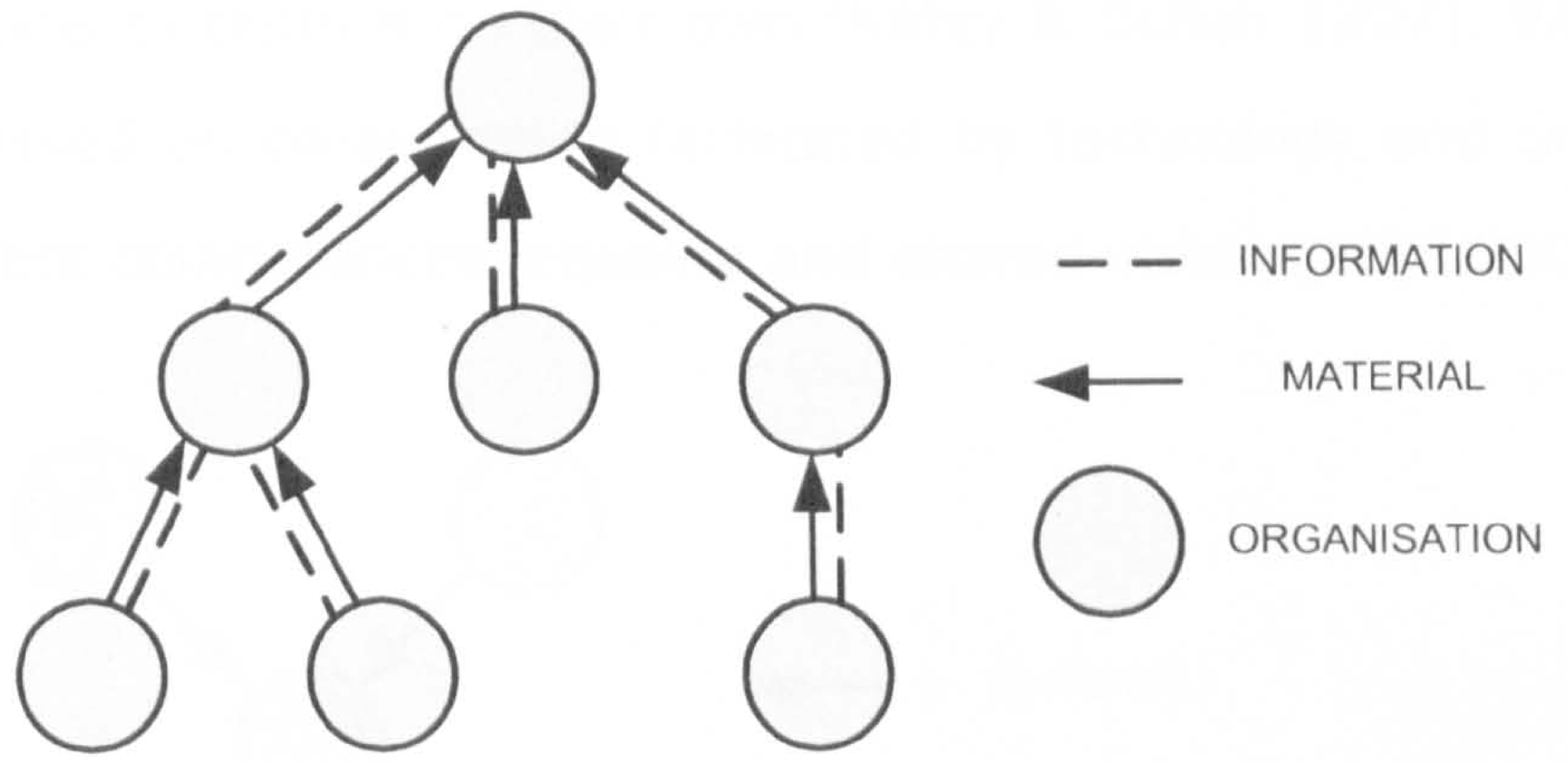


Figure 6: Production network type - hierarchy (Kornelius 1999, Thorelli 1986)

- Hyperarchy: is the opposed model to hierarchy. In a hyperarchy (Figure 7), all organisations communicate with each other. The increasing importance of this model is based on advances of information availability in the Internet which increases transparency and decreases bargaining power utilising lack of (price) information amongst collaborating organisations (Evans & Wurster 1997, Kornelius 1999, Thorelli 1986).

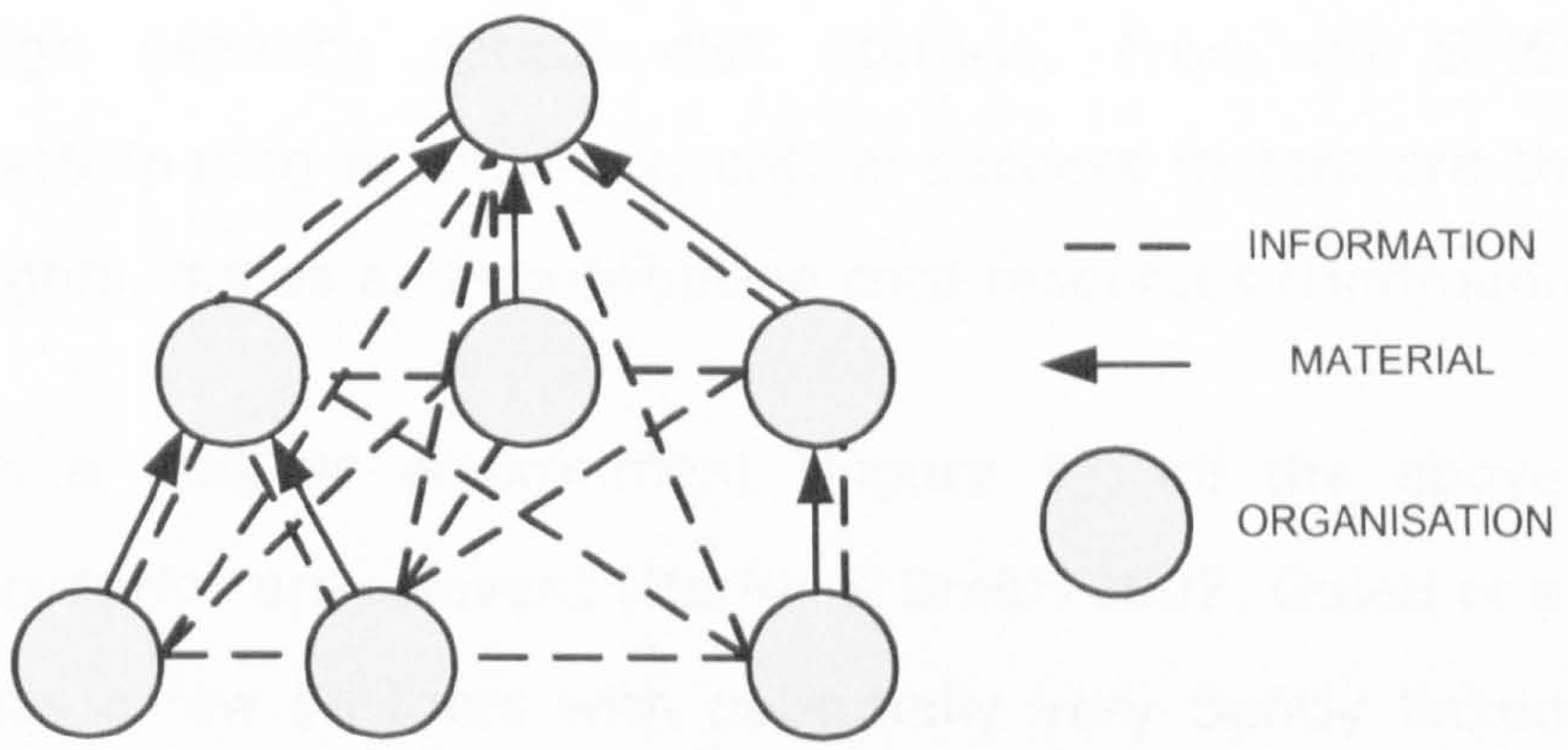


Figure 7: Production network type – hyperarchy (Kornelius 1999, Thorelli 1986)

- Virtual Enterprise: The virtual enterprise (Figure 8) is based on the ability to create temporary co-operations and to realise the value of a short business opportunity that the partners cannot (or can, but only to lesser extent) capture on their own (Katzy & Schuh 1997). Virtual enterprises are based on co-operation facilitated by technology and underpinned by trust, core competences, equality and shared vision (CIPS 2003).

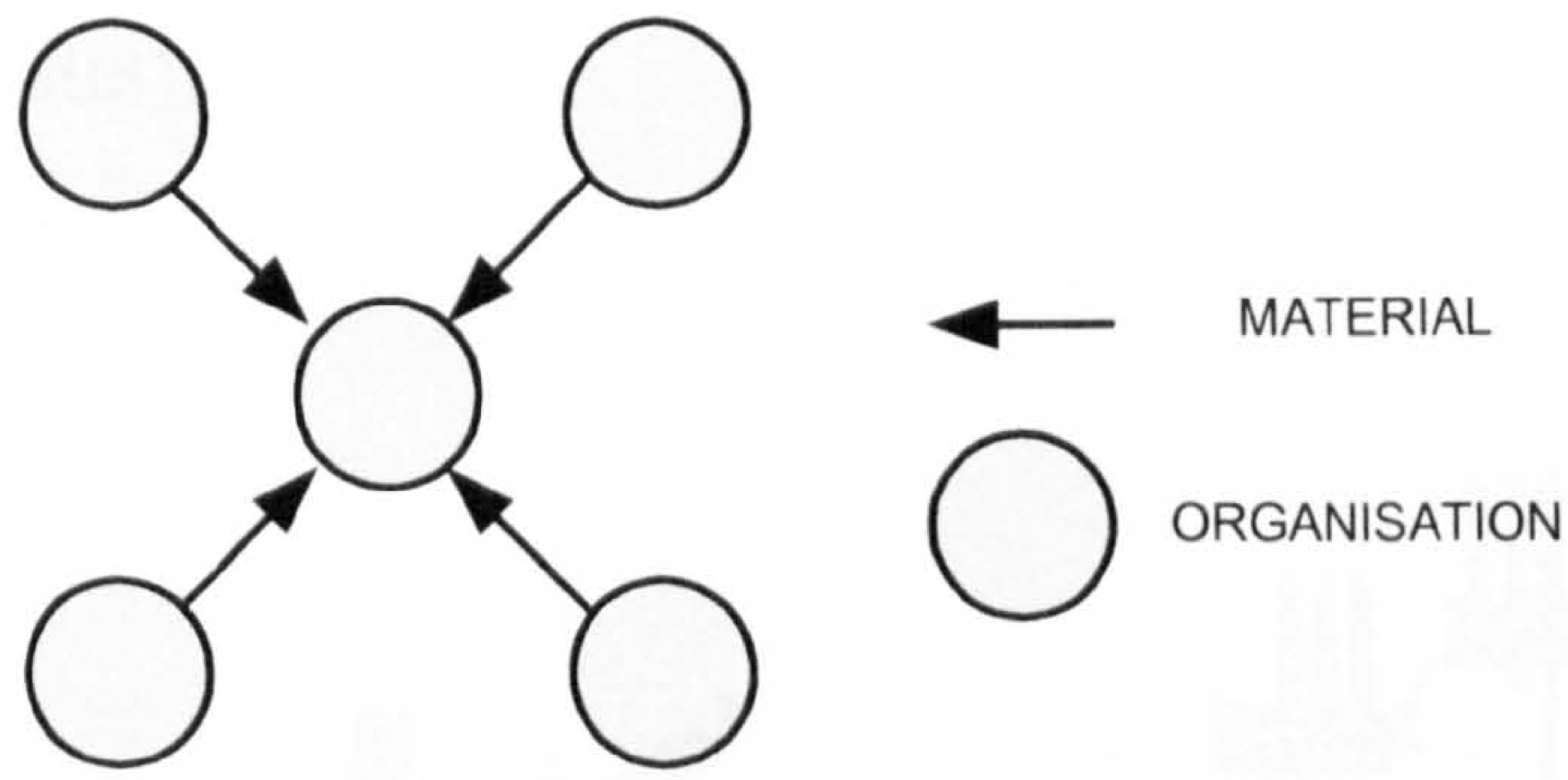


Figure 8: Production network type - extended / virtual enterprise (Kornelius 1999, Thorelli 1986)

- Strategic Network / Alliance: Typically large enterprises cooperate to achieve a common goal, which can be market dominance. Examples are the Star Alliance within the airline market or the Blu-ray Disc Association for high capacity optical disk storage. From an SME perspective when participating in alliances, critical success factors are the clear definition of rights, duties and contributing core resources (Hoffmann & Schlosser 2001).

In a realistic environment (Figure 9), all the above described network scenarios are relevant (BarNir & Smith 2002, Gulati et al. 2000). A company has a few partners with potentially very tightly linked business processes and personnel relations. At the next important network level around each company there are core suppliers, where personnel relations are maintained but with possible decreased business process integration. The third group can be considered as intermediary, for example, a web hub for Maintenance Repair and Operation goods (MRO) articles. Individual partners are interchangeable and integration of business processes might be desirable, for example, to automate large processing effort but low value transactions. The third and least important group are service providers and rarely used other suppliers which are easy interchangeable in most of the cases. The selection of a partner is another critical success factor for collaboration. Partners (including suppliers) should be selected to complement skills and resources (Akacum & Dale 1995, Bakos & Brynjolfsson 1993, Das & Teng 1998).

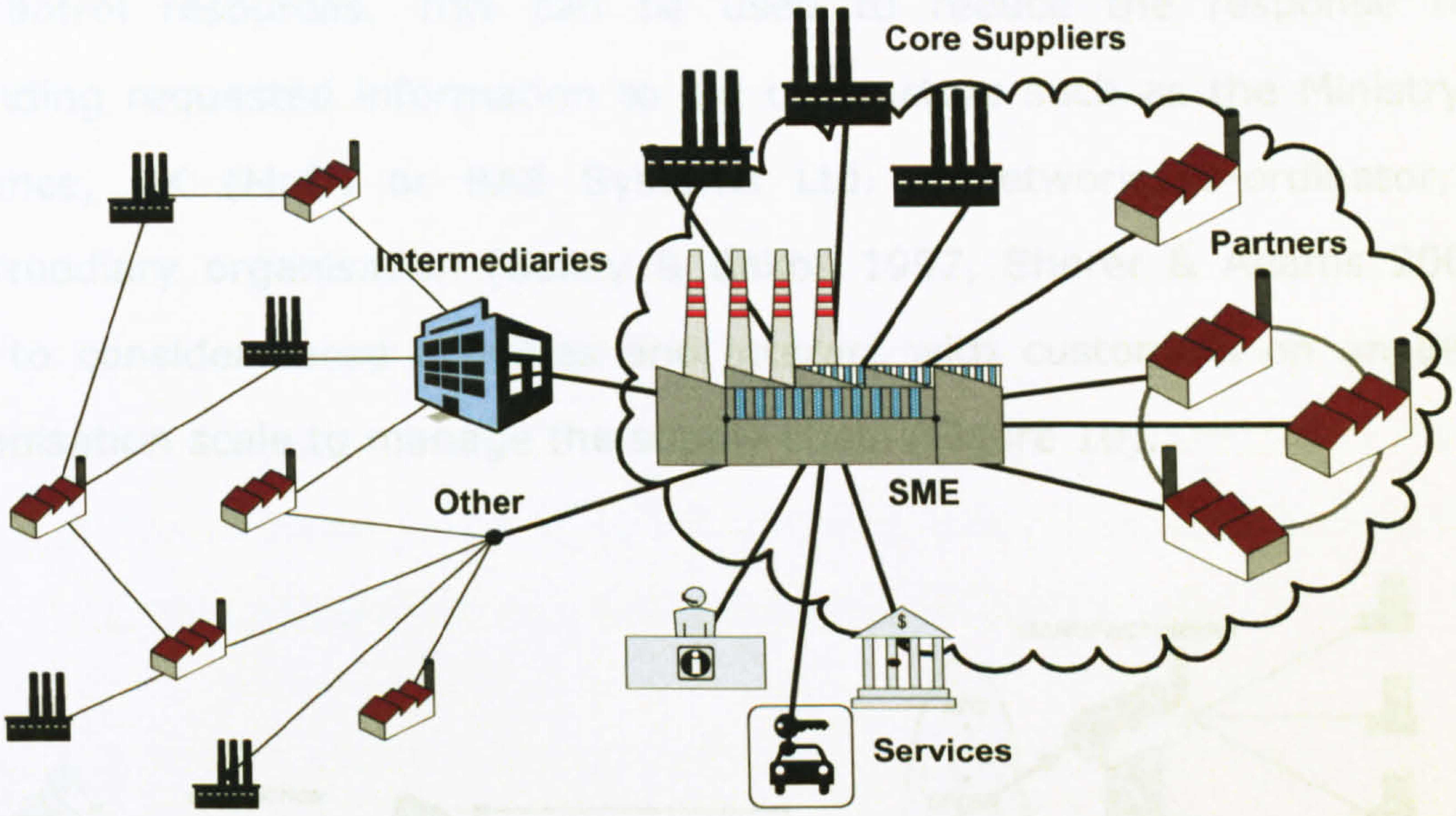


Figure 9: Realistic production network scenario for SMEs

A common academic approach is to group key concepts of inter-firm collaborations into categories (Ansoff et al. 1976, Nilsson et al. 2003, Varamaki & Vesalainen 2003) such as resources & specialisation, intensity of objectives & investment, formality of collaboration, uncertainty, use of power and socio-psychological influence. However, in reality SMEs will collaborate in a mixed mode focussing on changing objectives. This is one reason for an insufficient number of tools to form and manage collaborative networks (Varamaki & Vesalainen 2003). To accomplish a synthesis of different modes of collaboration Figure 9 summarises the model used for the work during this project. A complementary approach will be discussed in Chapter Seven.

One example of collaborative network co-ordination and management tool is Competence Profiling Methodology software (CPM) to manage core competences, services and processes for a group of companies (Armoutis & Bal 2003, IADET 2004), which is necessary to help the network coordinator to control resources. This can be used to reduce the response time providing requested information to big contractors such as the Ministry of Defence, UK (MoD) or BAE Systems Ltd. A network co-ordinator, or intermediary organisation (Bailey & Bakos 1997, Sherer & Adams 2001), has to consider these activities and interact with customers on an inter-organisation scale to manage the supply chain (Figure 10).

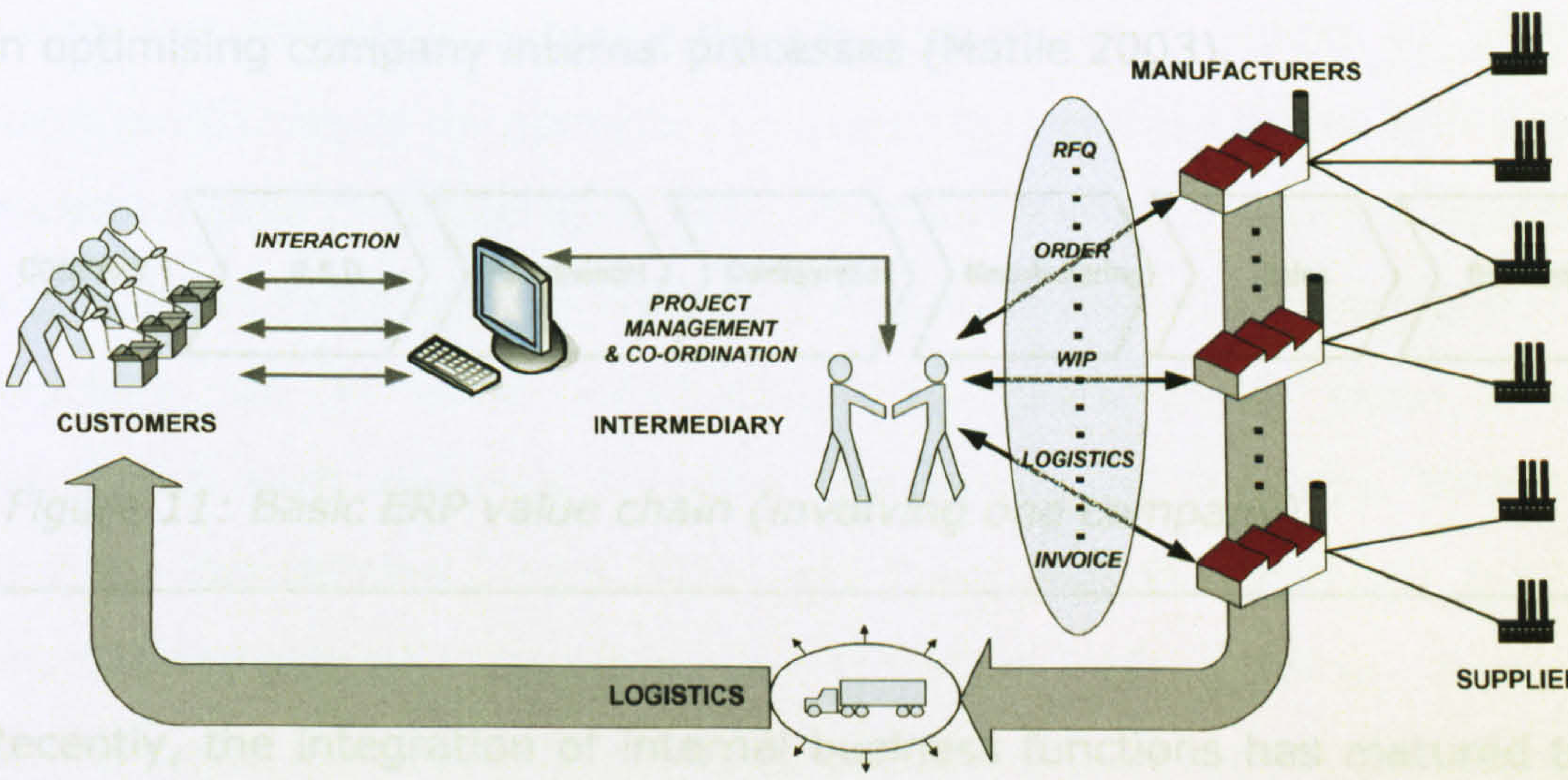


Figure 10: Network co-ordinator involvement within a production network

Most of the large SMEs own an ERP software license (van Everdingen et al. 2000) to run the business but some smaller companies work with paper based systems (Roberts & Wood 2002) according to the plan in the head of the managing director or develop their own ICT support (Olsen & Saetre 2007). In order to establish collaboration between SMEs it has to be recognised that each SME wants to be considered as an autonomous unit (Nilsson et al. 2003, Prud'homme et al. 2007). It is very difficult to look inside, to access staff or internal data.

Enterprise resource planning (ERP) (Soh et al. 2000) is an industry term for the broad set of activities supported by multi-module application software that help a manufacturer or other businesses manage the important parts of its business (Figure 11): product planning, parts purchasing, maintaining inventories, interacting with suppliers, providing customer service, and tracking orders (Software AG 2005). ERP includes much more than procurement, configuration, manufacturing, sales and distribution, omitting areas such as accounting, marketing this first stage of a symbolic model has the focus on core principals. However in the past, ERP systems were initially designed (as included in the 'E' for Enterprise) with a functionality focussing on optimising company internal processes (Matile 2003).

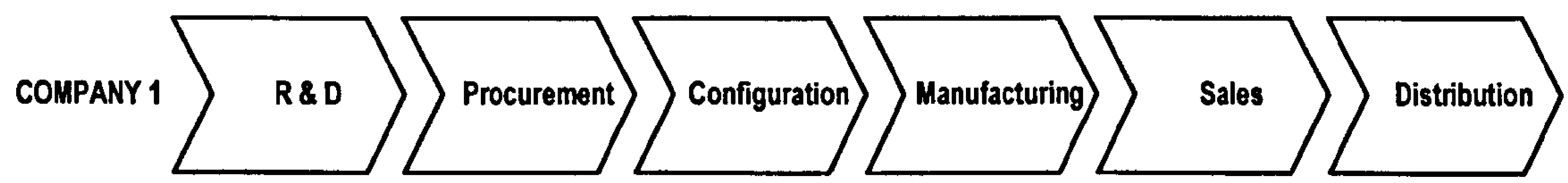


Figure 11: Basic ERP value chain (involving one company)

Recently, the integration of internal business functions has matured to the point where any further cost reduction potential has been exhausted (see also Figure 22). Here, supply chain management inherits the cost-reduction driver function (Tarn et al. 2002) by involving customers' and suppliers' information (systems) (see Figure 25). The way companies conduct their business is changing steadily and ERP systems must adapt accordingly, for example, taking into account a growing share of outsourced (Arnold 2000) e.g. manufacturing and distribution services (Figure 12). This leads to a growing emphasis on collaboration and increases the workload and complexity of procurement process. This scenario is much more difficult to estimate than simple material purchases (Ellram 2005).

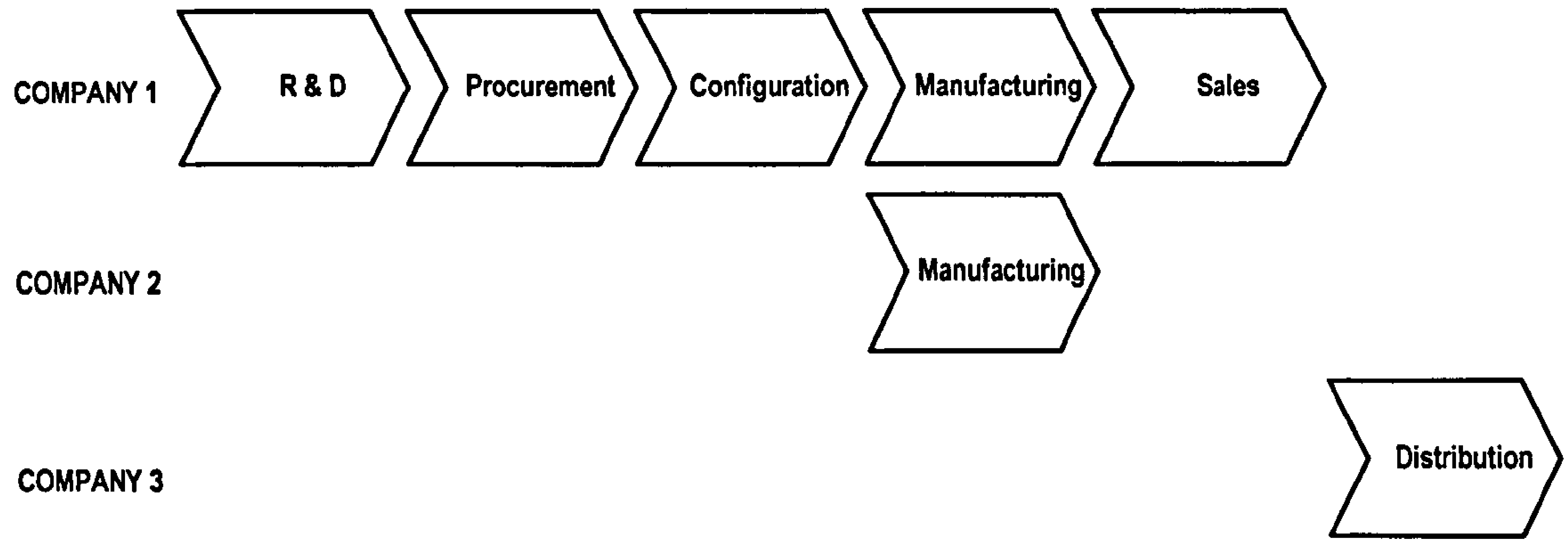


Figure 12: Today's typical value chain

Taking the allocation of tasks and services shown in Figure 12 (involving three companies as an example) as a starting point for future ERP business models, Figure 13 visualises a value chain comprising a network coordinator with several specialised collaborating organisations (Al-Mashari 2002). This structure can be found constituting the today's supply chain of a few companies such as Cisco or within the automotive industry. With trends such as globalisation (Trent 2003) and specialisation (Heshmati 2003) this inter-organisational structure is expected of growing importance (Christiansen & Maltz 2002, Do et al. 2006, Heshmati 2003) but outside the capabilities of the current generation of ERP systems (Alshawi et al. 2004, Lee et al. 2003, Olsen & Saetre 2007, Sharif et al. 2005).

From a collaborative point of view, an SME will be considered as an autonomous entity with defined interfaces to access and communicate. Physical interfaces can be exposed to a production network (Wiendahl & Lutz 2002) using, for example, competence profiling methodology (IADET 2004). Furthermore, core organisational processes can be captured but implementation of a multi ERP system (Alshawi et al. 2004) environment is currently not yet feasible (see Figure 22). Hence, it will be down to individual staff of participating companies to fulfil the requirements of the production network. This is the most difficult task considering the daily workload of SME employees and the additional required efforts related to the long-term success of the production network.

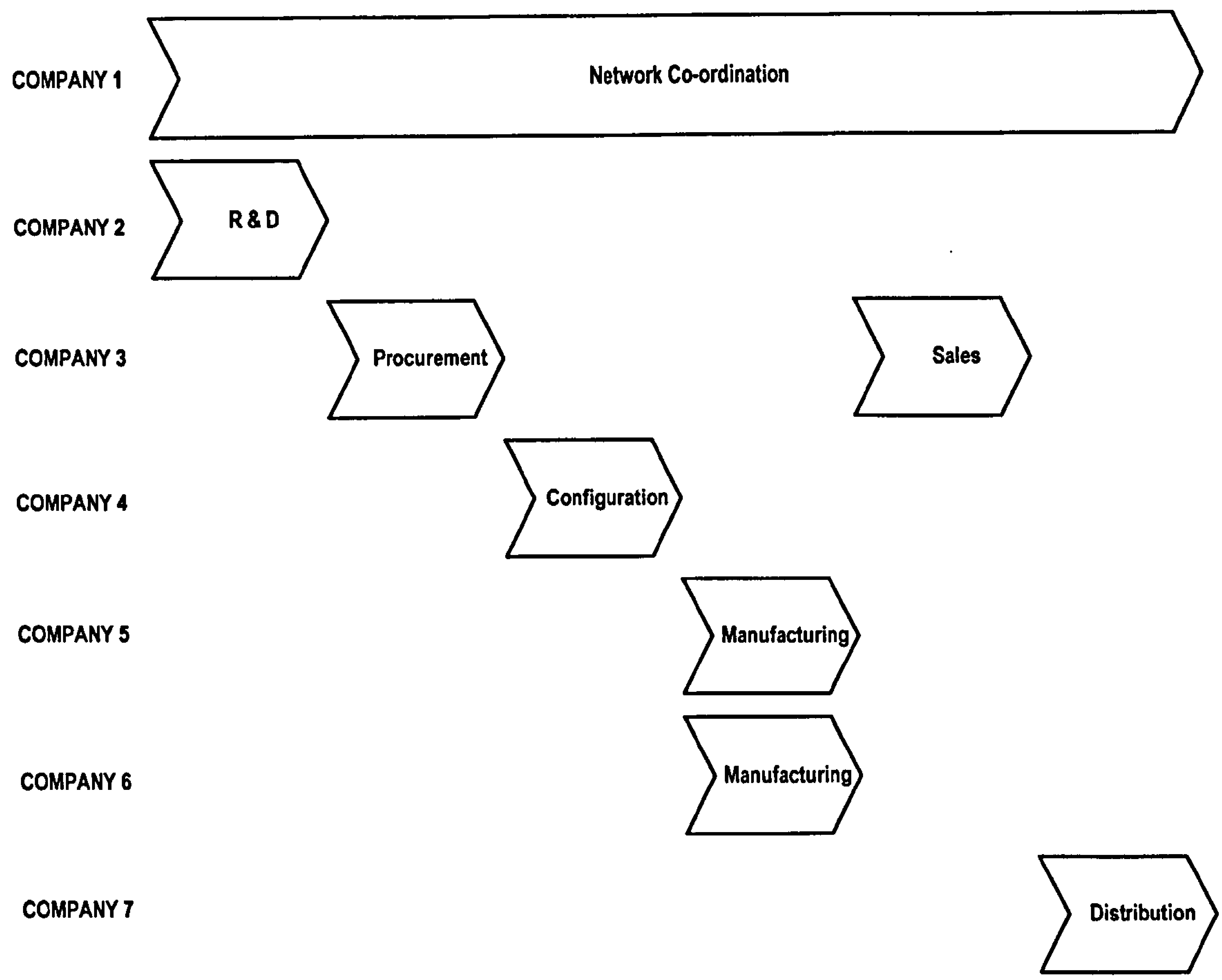


Figure 13: Future value chain

A successful implementation of collaboration has to start with people (Figure 14), agreeing on the process and using technology as a tool, as shown around the year 2000 when "electronic"-systems over promised and under delivered (Barnes et al. 2003, Barnes et al. 2004, Razi et al. 2004).

Most important, new technologies are always deployed to make one resource factor more efficient: People (Allen 2003, van Stekelenborg 1997). Another crucial factor is the involvement of the top management considering that (1) people habits will change, (2) the way the - procurement - process is conducted and (3) a new technology will be used. This is valid for individual companies but even more for collaboration across the own companies border, which leads to an in-depth case study and development model of a collaborative network in Chapter Seven.

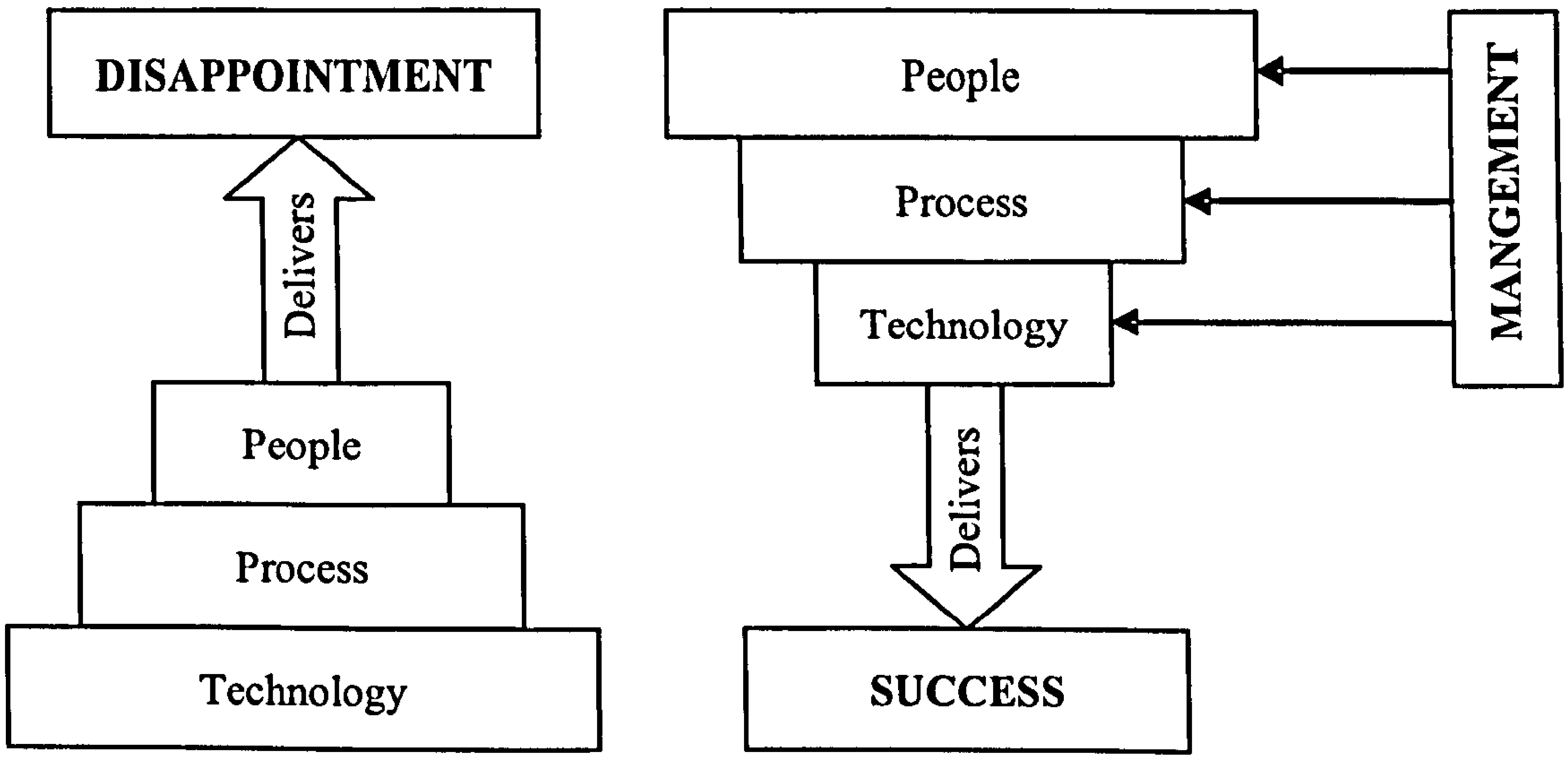


Figure 14: Implementation model for new technologies

2.2 Supply Chain Management

Current research into supply chain management SCM emphasises the 'competition of supply chains' over 'head-to-head-competition' between enterprises (Poirier 2003, Stock 2000) and highlights especially the importance of the adequate management of inter-organisation collaboration (Lancioni 2000, PLS RAMBOLL 2001). On the other hand, research into SCM is generally focused on vertical integration (Varamaki & Vesalainen 2003) of supplier-enterprise-customer and not on collaboration between independent organisations (Hicks et al. 2000, Serve et al. 2002). Likewise, the majority of successfully implemented electronic procurement / supply chain solutions are developed within large organisations (Puschmann & Alt 2005, Stefansson 2002) with large buying volumes and a limited number of involved suppliers along the mutual product value/supply chain to exchange information.

SCM has taken different directions and there are a variety of definitions available (Cousins 2005, Jeeva 2004, Johnson & Whang 2002, Larson & Halldorsson 2002, Mentzer et al. 2001, van Weele 2005). Viewing the term "supply chain management" literally, it consists of three parts:

- Supply: An organisation has its supply of incoming materials, information (and other inputs) but also serves the supply of customers.
- Chain: Incoming and outgoing streams are connected through the organisation's value creation.
- Management: Processes along the value chain have to be managed between the involved actors (Lambert 1998).

Three important parts of SCM are the subject of this thesis: collaboration, procurement and applying ICT. SCM encompasses the integration and management of key business processes across the supply chain, whereas the often related term logistics is considered historically (Oxford 2000) as the activity of organising the movement, equipment and accommodation of troops. In a more modern interpretation logistics is the commercial activity of transporting goods to customers (Bakos & Brynjolfsson 1993, McGinnis & Cancro 2003, Oxford 2000). Often, practitioners and academics (Larson & Halldorsson 2002) consider the SCM focus towards technology and process; purchasing is related to the dealing with suppliers.

For the purpose of this research, the following view is applied: Supply Chain Management (SCM) encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. It includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. Supply Chain Management integrates supply and demand management within and across companies' boundaries and relationships. Supply Chain Management is an integration function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performance business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology (CSCMP 2003).

This is confirmed when defining Logistics Management as "the efficient planning, improving and control of the goods, services and related information flow and storage from its origin to its final destination or selling point, complying with customer's requirements" (CSCMP 2003).

In essence, from a perspective of a collaborative consortium, SCM comprises inter-enterprise and cross-functional logistic and business processes: logistics, sourcing and manufacturing. SCM is the tool to coordinate collaboration.

The starting point for the considerations of supply chain management within this thesis is an autonomous SME utilising an ERP system locally to run the business and the growing necessity to collaborate within the value chain (Tarn et al. 2002). Within a manufacturing company, the actual time of adding value to a product or process is very short compared with idle time waiting for the next action (Bragila et al. 2006, Hwang 2006). SCM aims to reduce "net value adding time" and idle periods as well (PSL 2000). Individual companies might even have an ERP system that provides SCM functionality but it is unlikely that all participating companies of the consortium use the same ERP system. Furthermore, the implementation of SCM within the ERP system may not be compatible with other systems (Hwang 2006, Lee et al. 2003, Sharif et al. 2005). Other companies might not use any IT (Roberts & Wood 2002) support to run the business or have their own in-house system (Olsen & Saetre 2007).

Supply chain management requires a shift away from a traditional business function approach (Mentzer et al. 2001), which considers only the own company towards integrated business processes across companies' borders. A Supply Chain Operations Reference (SCOR) framework for this scenario was developed by the Supply Chain Council (Bolstroff 2002, Kasi 2005, SCC 2004), which includes standard terminology, best practice, common performance metrics and associated benchmarks (Huan et al. 2004) for this purpose. Applying the SCM concept to a group of collaborating SMEs the following characteristics are important to consider (Reeds 2000):

- SCM is an evolving set of management philosophies;
- SCM seeks to unify both internal and external competencies;
- SCM fosters alliances and trust throughout the supply system;
- SCM demands innovation and synchronization of processes;
- SCM focuses to optimize the delivery of products, services, and information.

Relevant to the deployment of SCM within a collaborating group is the alignment of individual companies' business focused ERP systems towards a holistic supply chain (Davenport & Brooks 2004). SCOR presents a common language and philosophy, which can result in a business processes re-engineering (McCormack et al. 2003, Oesterle et al. 2000) to align. With system inherent performance metrics (Bolstroff 2003, Nyhuis & Wiendahl 2003), it provides measures to indicate progress or achievement. When using the same metrics within a group of companies and scoring their priorities, metrics will provide the "as is" input for a gap analysis (Scott 2002) whereas "best practices", research papers or SCOR standard processes contribute towards "to be" actions. In this context another frequently used term is Key Performance Indicator (KPI), a benchmark measurement based on objectives, targets and defined industry standards

(Bullinger et al. 2002, Gilmour 1999, Hanman 1997). SCOR initially divides the management of the entire company into the following core processes (Figure 15): Plan, Source, Make, Deliver, Return and Enable activities (SCC 2004). Each process (Level 1) contains process elements (Level 2) with tasks (Level 3, not shown) and activities (Level 4, not shown) to fulfil.

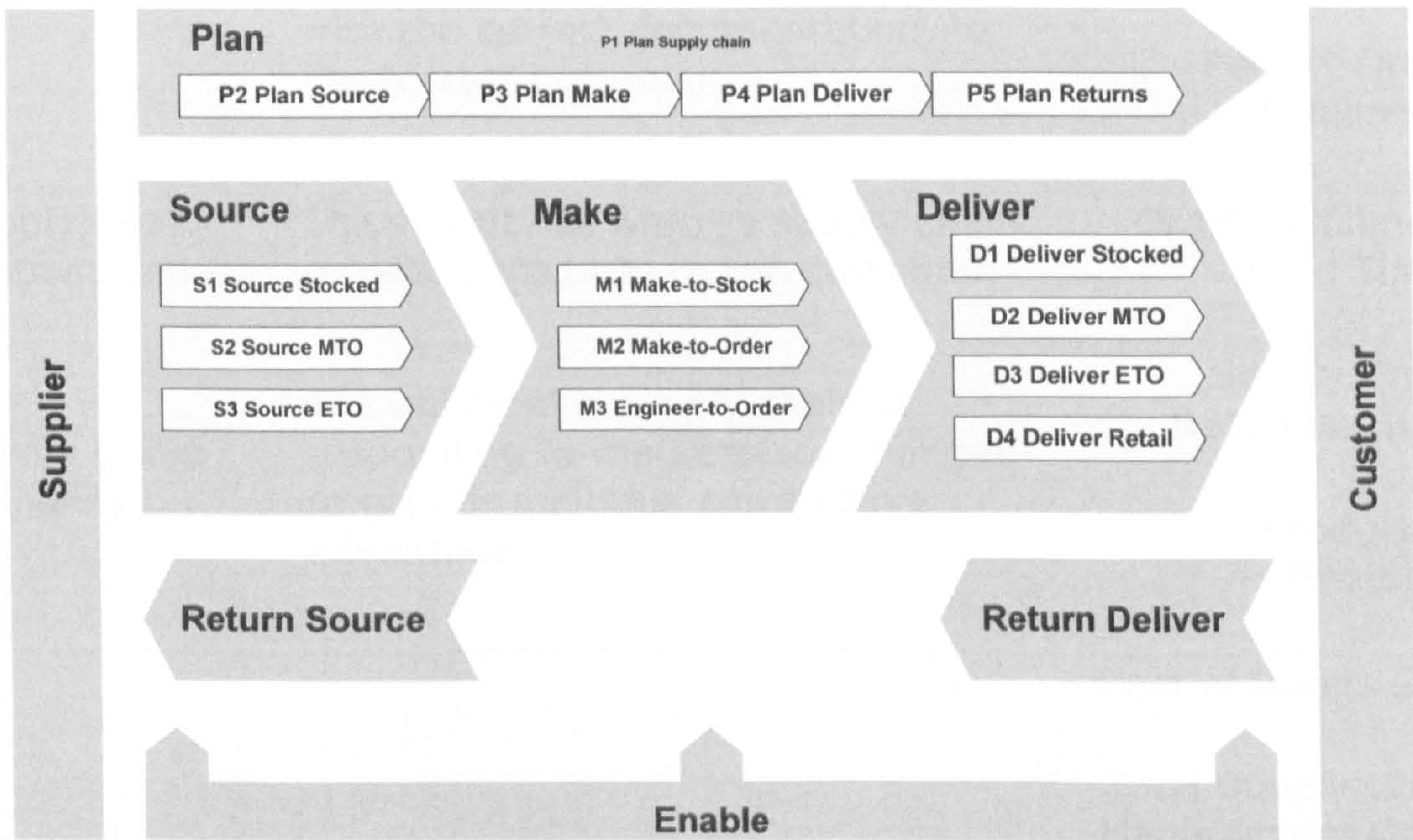


Figure 15: SCOR-model 6.1 – integrated business processes for SCM (SCC 2004)

From an implementation perspective, there has to be an educational step first (Bolstroff & Rosenbaum 2003). This should include training in SCM, SCOR background and finish with a mutual agreement on terminology, or for example, supply chain cost or delivery performance. Then the company starts collecting data (Table 1) internally to record level 1 metrics (SCC 2004), which should be available through the internal ERP or accounting system (Cancro & McGinnis 2003). This individual company information is compared with competitor's metrics and brought in line with the business strategy.

Performance Attribute	Performance Attribute Definition	Level 1 Metric
Supply Chain Delivery Reliability	The performance of the supply chain in delivering: the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.	Delivery Performance Fill Rates Perfect Order Fulfillment
Supply Chain Responsiveness	The velocity at which a supply chain provides products to the customer.	Order Fulfillment Lead Times
Supply Chain Flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.	Supply Chain Response Time Production Flexibility
Supply Chain Costs	The costs associated with operating the supply chain.	Cost of Goods Sold Total Supply Chain Management Costs Value-Added Productivity Warranty/Returns Processing Costs
Supply Chain Asset Management Efficiency	The effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.	Cash-to-Cash Cycle Time Inventory Days of Supply Asset Turns

Table 1: Supply Chain Performance Attributes and Level 1 Metrics

Benchmarking data from other companies is available through subscription to organisations web sites like Hoovers (Hoovers 2004) or PMG Benchmarking (PMG 2005). Collecting this data (Carter & Monczka 2005) is a tedious undertaking and may also not always be possible in the expected way because the internal setup of the company (for example, cost and budget centres or department structure) might be different from the initial SCOR definition.

Certainly, this process should initiate a serious discussion about internal structures and awareness about important supply chain metrics. Subsequently, a gap analysis is conducted (Bolstroff & Rosenbaum 2003) comparing the company data with competitors, and an appropriate target is set for superiority, average or competitive approach for individual metrics (Table 1) depending on the business strategy focus (Pittiglio et al. 1999).

For a limited number of important gaps further business process re-engineering steps after the SCOR procedures need to be conducted to meet supply chain parity for minor weaknesses or achieve supply chain superiority for core business processes. Then the benchmarking and the re-engineering process starts again and will be a continuous management task (Porter 1996).

The performance metrics are internal, external and shareholder related; they target superiority, advantage and parity compared with those of competitors. They should be set 'SAPP' (superior, advantage, parity and parity) and be in line with the business strategy of the company (SCC 2004). Each element (Figure 15) can be broken down into several level 1 metrics (Table 1) characterising the high level business scenarios in a company. Further decomposition into level 2 will constitute the material flow, for example, Make-to-Order. The following level 3 contains characteristics of work and information flow followed by level 4 with actual tasks (Bolstroff 2002).

Supply chain capabilities of companies applying the SCOR model need to be developed as an evolutionary process and can be classified using (Ginsberg 2002):

- Functional focus: discrete supply chain processes and data flows well documented and understood. Resources managed at departmental level and performance measured at functional level.
- Internal integration: company-wide process and data model continuously measured at the company, process, and diagnostic levels. Resources are managed at both functional and cross-functional levels.
- External integration: Strategic partners throughout the global supply chain collaborate to:
    - identify joint business objectives and action plans;
    - enforce common processes and data sharing;
    - define, monitor, and react to performance metrics.
- Inter-organisation collaboration: IT and e-business solutions enable a collaborative supply chain strategy that: (a) aligns participating companies' business objectives and associated processes, and (b) results in real-time planning, decision making, and execution of supply chain responses to customer requirements.

As another example, solutions in particular within the retail industry use the Collaborative Planning Forecasting and Replenishment (CPFR) model (VICS 2004). Where SCOR views the business aiming to improve the individual companies' performance based on metrics, the CPFR defines the "how" companies can perform collaborative processes (Nokkentved & Hedaa 2001). Partners share their plans for future events and treat exceptions from these forecasts in a predefined approach. Traditionally, CPFR users are within the retail consumer goods industry and use technologies like Vendor Managed Inventory (VMI) and Electronic Data Interchange (EDI), however the model has extended towards 3PL (3rd Party Logistics provider) to manage "n-tier CPFR" (Lewis et al. 2001).

2.3 Collaboration in purchasing

Collaboration in purchasing has a long tradition that extends past back to medieval trade guilds (Schotanus 2005). The first sources referring to inter-firm cooperative sourcing (Essig 1999) in the way it is used today are even much older (Gushee & Boffey 1928, Mitchell 1937).

A common understanding of "collaborative purchasing" is the coordinated conduction of the purchasing process across at least two independent organisations leveraging demand aggregation for lowering costs, number of transactions or increasing service levels (Essig 1999, Hendrick 1997, Nokkentved & Hedaa 2001, Schotanus 2007b). This indicates that potential items for inter-organisation collaboration are rather standardised but also that the relation with involved suppliers will be more towards arm's length than co-operation (Schotanus 2007). Even though many literature suggests a move towards supply chain collaboration (Poirier 2003), which might actually happen with a reduced number of core and very specific suppliers (Figure 9), this also indicates that companies operate very likely in a mixed mode of collaboration for core items and arm's length or competitive bidding for other parts (Gelderman 2003, Knudsen 2003, Schotanus 2007b).

Key aspects of purchasing collaboration within a consortium are mutual trust, commitment without opportunistic behaviour and purchasing process (culture) synchronisation (Aaltio-Marjosola & Virolainen 2003, Chen & Paulraj 2004). As a result an assigned network coordinator is necessary (Knight 2005, Simatupang et al. 2002). Hence, a company acting as intermediary or network coordinator can distinguish itself from competitors through being able to set-up cooperation that others cannot achieve. How to identify and implement collaborative activities will be discussed in Chapter 7.

Standard communication takes place between purchasing and sales departments, whereas collaboration requires more intensive interaction (Chen & Paulraj 2004, Gebauer 1998, Zacharia et al. 2007) involving design, engineering, quality and other departments at the project level (see Figure 5). With increasing diversity collaboration can become even more complex (Parker 2000). Here, inter-firm communication is critical when collaborating in purchasing (Laing & Cotton 1997). Due to the advance of Internet (Granot & Sosic 2005) related technologies change rapidly; this subject will be further explored in the Chapters Four and Five.

In the field of electronic procurement there are abundant and sometimes contradictory quantitative publications, principally concerning large enterprises (Carter 2000, Hughes 2002, Ogden 2005, Williams 2006, Wyld 2004). In particular, for SMEs with limited (knowledge) resources the conflicting research creates ambiguity in perception and discourages adoption. New and revised technologies are emerging rapidly because commercial software vendors are under pressure to distinguish themselves from their competitors, but academic publications are not lagging behind (Cousins 2005, Morgan 2003, Tan 2001).

With different products, services, organisational culture and structure, purchasing implementations will vary from company to company. Thus, a classification and modelling from an academic perspective is difficult. As a starting point towards an understanding of the procurement process and terminology Figure 16 highlights important concepts related to this research (Kauffman 2002).

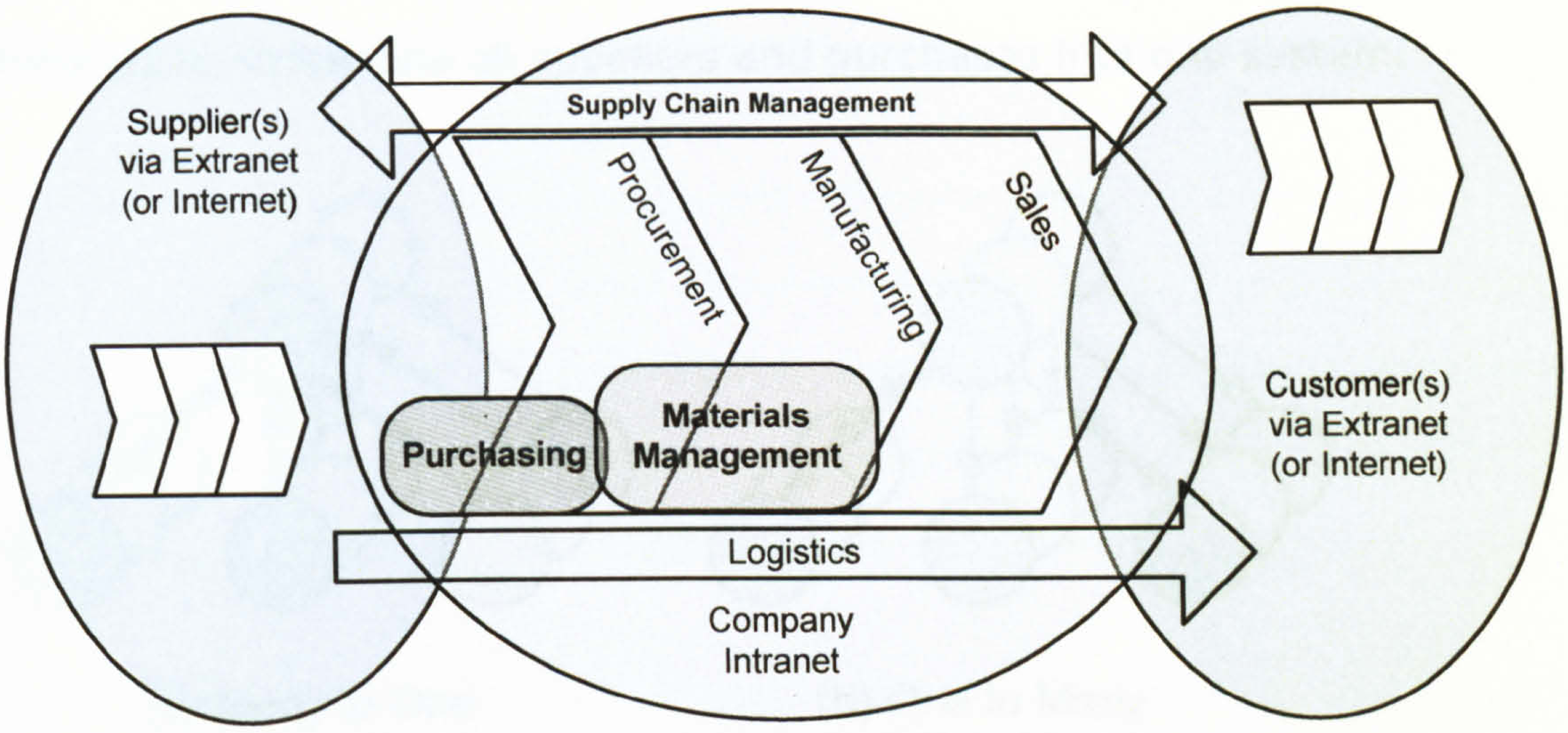


Figure 16: Procurement process model with related concepts

Starting from the model of a free market (Dai & Kauffman 2002, Thorelli 1986) with a free exchange of goods and services where one party is selling and one is buying; the classic sell-side model (Figure 17 a) is applied when many buyers access a supplier's web site/telephone sale (Bartezzaghi 2004). This is the preferred method applied by companies to have customers within their sales mechanism without competition. For purchasers it leads to a situation accessing many suppliers or seller's web sites (Porter 2001). This is the most common scenario selling companies are interested to develop (Attaran 2001, Batenburg 2007, Chau 2003, Deeter-Schmelz et al. 2001). It suits the top priority and objective of every company: the generation of income through the sale of services and products (see Chapter 4.2).

On the other hand applying the buy-side model a buyer could receive product information from many suppliers (Figure 17 b), which could place all suppliers in a competitive situation. Hence, the interest of suppliers is very low (Hendrick 1997, Schotanus 2007, Wang & Archer 2004). This is a typical e-procurement scenario (Dolmetsch 1999) where a buying company attempts to streamline all suppliers and purchases into one system.

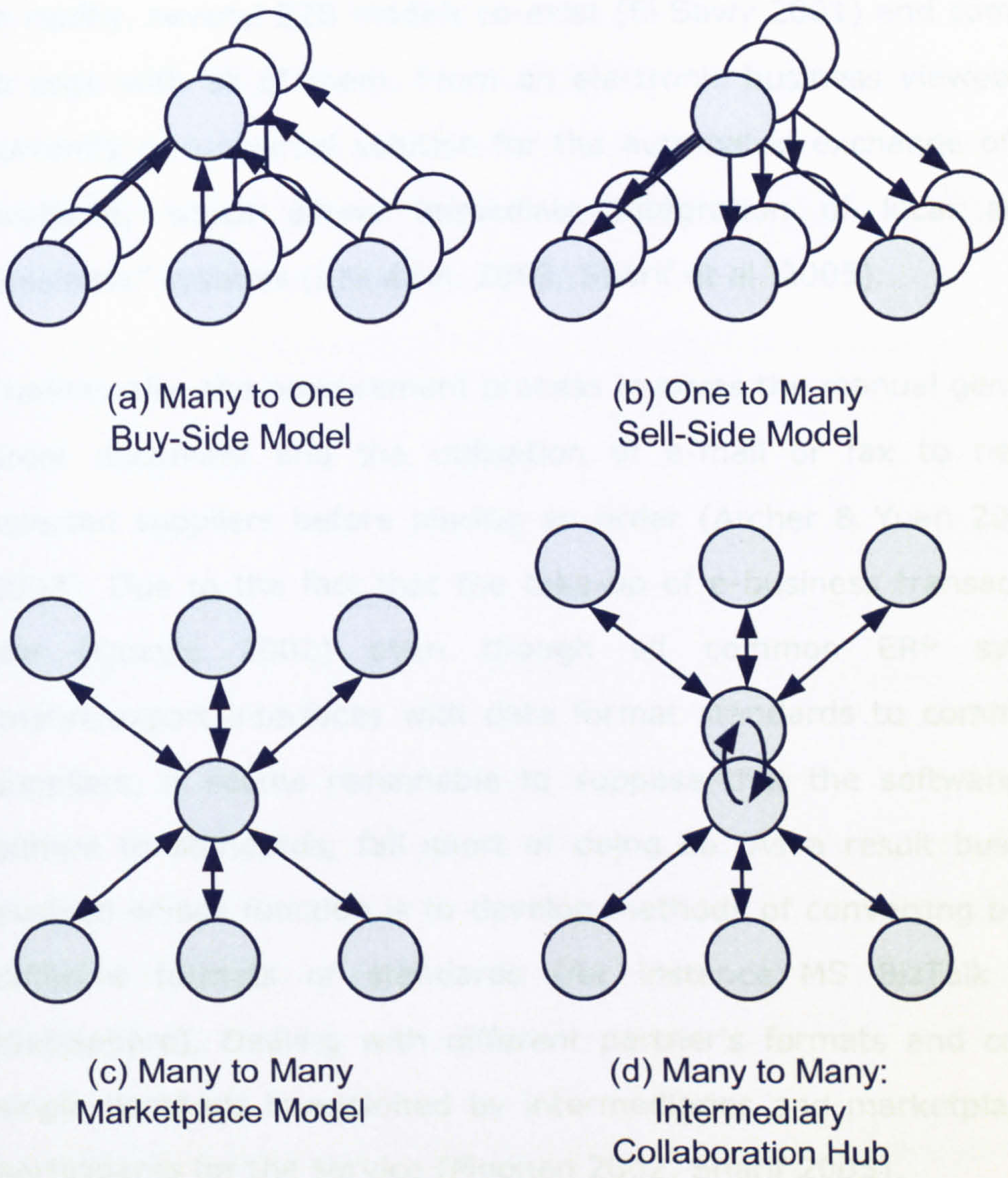


Figure 17: Generic B2B models for buyer seller communication

A generic marketplace (Figure 17 c) will allow many buyers to communicate with many suppliers (Dai & Kauffman 2002). Usually marketplaces are interested in generating as many transactions between a maximum of participants to justify fees (Grieger 2004). This leads to the "Intermediary Collaboration Hub" model (Figure 17 d) introducing an additional objective to serve either buyer or supplier side (a marketplace itself could be considered as a "neutral" intermediary) as discussed throughout this thesis (Bailey & Bakos 1997, Moonen 2002, Sherer & Adams 2001).

In reality, several B2B models co-exist (El Sawy 2001) and companies have to cope with all of them. From an electronic business viewpoint, there is currently no universal solution for the automated exchange of information available, which allows immediate integration of local and partners "business" systems (Lee et al. 2003, Sharif et al. 2005).

Traditionally, the procurement process involves the manual generation of an order document and the utilisation of e-mail or fax to negotiate with selected suppliers before placing an order (Archer & Yuan 2000, Knudsen 2003). Due to the fact that the take-up of e-business transactions is very low (Quayle 2002) even though all common ERP systems have import/export interfaces with data format standards to communicate with suppliers, it seems reasonable to suppose that the software claiming to adhere to standards, fall short of doing so. As a result businesses have evolved whose function is to develop methods of converting between these different formats or standards (for instance MS BizTalk Server, IBM WebSphere). Dealing with different partner's formats and collecting their single demands is exploited by intermediaries and marketplaces, charging participants for the service (Moonen 2002, Sharif 2005).

As discussed in Chapter Four in detail procurement is (a) covering a range of activities from clerical to strategic, (b) performed by people with a variety of backgrounds and (c) serving companies in different market positions. However, the procurement life cycle consists of the following generic steps (Archer & Yuan 2000, Knudson 2003, Lonergan 2003):

1. Information gathering;
2. Supplier contact;
3. Background review;
4. Negotiation;

5. Fulfilment;
6. Consumption, maintenance, disposal;
7. Renewal.

There are many publications discussing the "strategic" importance of purchasing (Carr & Pearson 1999, Cavinato 1999, Nollet et al. 2005, Rich & Hines 1998, Spekman et al. 1994). A business strategy relates to how a company intends to realise their business goals on a long-term basis (COED 2005). Taking into consideration the definition of a strategic advantage that differentiates a company from a competitor and the definition of purchasing above, this level of importance can be denied in particular for SMEs (Ramsey 2001). In industrial practice the procurement department is an externally orientated market-support function (Hughes et al. 2004, Ramsey 2001) and in particular within SMEs at a low priority (Quayle 2003).

In essence, the purpose of the purchasing function within an SME is to assure the required supply following the company's strategy (Chen & Paulraj 2004). This is the starting point for considerations about the procurement function in Chapter Four leading to the development of a new purchasing framework more appropriate for SMEs.

Purchasing is of vital importance when it comes to the decision of whether a product should be produced in-house or purchased from an external supplier (Arnold 2000, Lankford & Parsa 1999). Once the decision has been made to out-source, the company loses a core-competence and replaces it with a bought in item. In many cases, depending on the circumstances, this leads to a growing importance of procurement (Carter et al. 2000, Hughes 2003). Hence, procurement complexity increases and a dependency to an external supplier is introduced.

Exceptions where purchasing may provide a strategic advantage for a company are when accessing suppliers which are (1) unknown to competitors, (2) locked from competitors (White & Hanmer-Lloyd 1999) or

(3) the way of purchasing cannot imitated by competitors (Ramsey 2001). However, materials, services or products on the market are usually available to competitors as well.

From a perspective of a potential purchasing collaboration it is important to consider that owner manager or a small number of employees conduct or influence the purchasing function within an SME (Quayle 2002). Here, procurement is strongly related to the "lifestyle" policy (Gulati et al. 2000, Morrissey & Pittaway 2004). On the other hand, there are many sub-contractors in the manufacturing sector without real unique competences where purchasing serves the manufacturing supervised by management or owner (Christiansen & Maltz 2002, Salo & Lukka 2004).

In procurement, collaboration has been extensively exploited over the last few decades (Essig 1999). There is a small number - about 50, according to (Anand & Ravi 2003) - of collaborative purchasing market places run by buyers and suppliers. However, considering their potential, which is actually recognised by SMEs too (Corsten & Zagler 1999, Huber 2001, Morrissey & Pittaway 2004, Vigoroso 1998) only a few collaborative purchasing consortia are known (Anand & Ravi 2003). In general, SMEs desire the development of purchasing consortia but, at the same time, it is not considered as feasible (Quayle 2002). There must be an explanation for this contradiction between potential, the limited research and implementation of collaborative electronic procurement. The reasons will be examined in the following chapters.

Considering (electronic) procurement as part of overall supply chain management, previous research focussed predominately on the vertical supply chain of large organisations (Smith & Buddress 2005, Varamaki & Vesalainen 2003), neglecting closely collaborating groups of local SMEs with similar activities. In this research, the 'horizontal' supply chain based on work within a group of local SMEs is observed (Eßig 2000). Collaborative purchasing is addressing many of the current problems in purchasing (Figure 18), most important cost pressure (Eyholzer 2000).

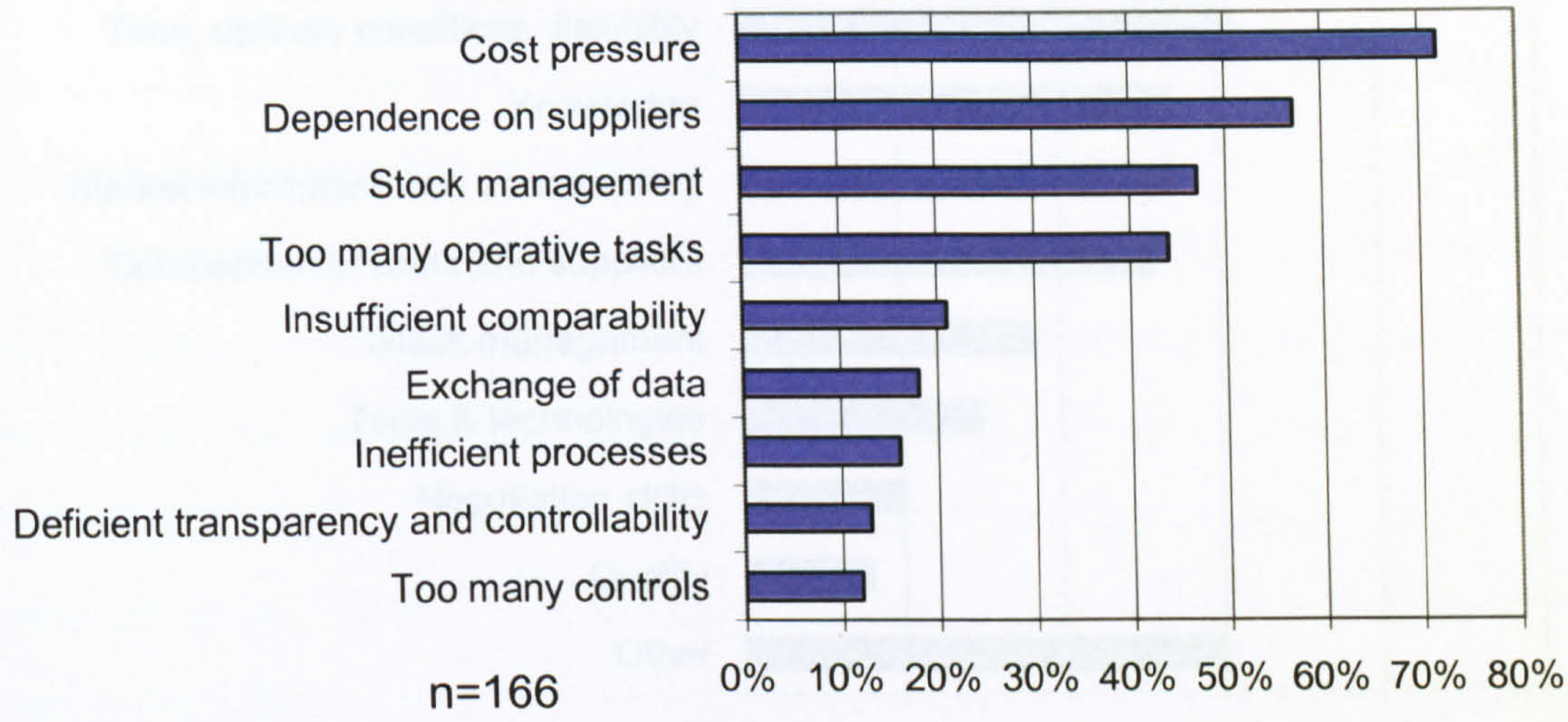


Figure 18: Procurements problems (Eyholzer 2000)

Collaboration in procurement is supposed to improve the individual company's situation. Considering the top ten procurement success factors (Figure 19), collaboration can contribute to the majority but not the important two (Eyholzer 2000).The main objective of collaboration is cost reduction and it is unlikely that collaborative procurement will improve relations with suppliers. Thus, important suppliers might not be involved in these initiatives (Hendrick 1997, Schotanus 2007, Wang & Archer 2004). Also, collaboration can develop best practices on process organisation of internal workflow conduction within the consortium but only over a long period. Certainly, tools and deployed technologies will be enhanced during collaborative electronic purchasing initiatives together with market knowledge (Alyesworth 2003, Hendrick 1997, Nollet & Beaulieu 2005a, Sickinger 1996).

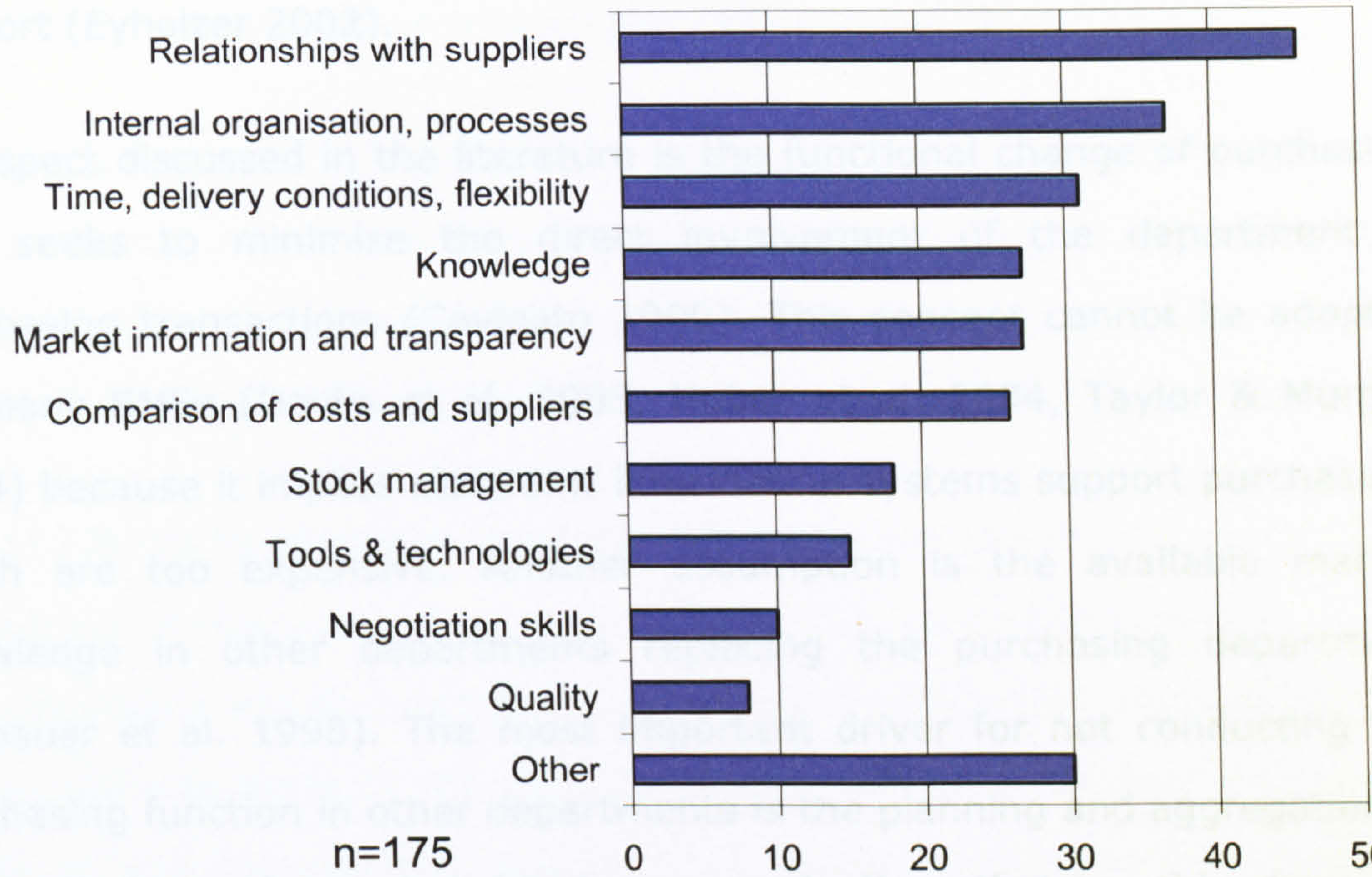


Figure 19: Procurement success factors (Eyholzer 2000)

However, electronic integration does not appear in purchasing success factors (Huber 2002). The trend towards an over-inflated value of the many Dotcom's and the subsequent collapse (Barnes et al. 2004) of their stock market values has established a certain caution (Drew 2003, Zheng et al. 2004) to employ e-technologies even though the advantages are obvious. Early electronic procurement applications were only limited to catalogue goods not able to implement requirements in services, which can constitute 30%-50% of the indirect expenditure (Minahan 2004). Regarding the adoption of e-procurement processes within SMEs a negative view is amplified by very expensive and complex ICT systems (Fornasiero & Zangiacomi 2006, Zheng et al. 2004), which realistically are not flexible enough to serve several 'strong' partners, for example, in the case of an SME working between and within different vertical industrial sectors (Varamaki & Vesalainen 2003). Usually, e-procurement solutions are successfully implemented by organisations that are focused on their own business processes and are capable of standing alone without cluster support (Eyholzer 2002).

An aspect discussed in the literature is the functional change of purchasing that seeks to minimise the direct involvement of the department in purchasing transactions (Cavinato 1999). This concept cannot be adopted by many SMEs (Davila et al. 2003, Huber et al. 2004, Taylor & Murphy 2004) because it implies electronic information systems support purchasing, which are too expensive. Another assumption is the available market knowledge in other departments replacing the purchasing department (Gebauer et al. 1998). The most important driver for not conducting the purchasing function in other departments is the planning and aggregation of demands (even in an individual company). Nevertheless, this does not mean that there are no implications on the change of the purchasing function for SMEs that should be addressed by increased knowledge in and cooperation with other departments (Cooper 2007).

An electronic purchasing workflow promises a significant process time reduction and increased supplier variety (Davila et al. 2003). Electronic procurement in general consolidates the procurement function into one application but decentralises the actual workflow towards the staff with the technical expertise (Gebauer et al. 1998). However, within one application, demand aggregation and contract co-ordination are still possible; notification and authorisation can cycle much faster using web based or email alerts (Dolmetsch 1999, Eyholzer 2002). Across different departments or even organisations, using electronic procurement the rationalisation of (approved) suppliers will be based on unbiased metrics (NePP 2004).

Depending on the actual value of the purchase item the processing costs can be considerably higher, for example, about €45 for SMEs and up to €200 for large multinationals (Kamann 2003), which is obviously a potential solution both for electronic purchasing and for collaboration. The expected saving when utilising electronic procurement accordingly vary from 4-7.5% (NePP 2004) of the total of process cost and purchases.

A potential obstacle is, however, the additional level of complexity added to the workflow, when collaborating with other companies (Ellram 2005, Parker 2000, Tan & Shaw 1998). There are many forms of co-operation in purchasing (Arnold 1996, Essig 1999, Schotanus 2005, Varamaki 1996):

- Joint forces to negotiate contracts and aggregate purchasing volume;
- Sharing of resources, such as specialists, ICT, bought-in services;
- Information and knowledge exchange: staff with expert knowledge must be willing to commit! The purpose of such collaboration could be the set-up of the purchasing process itself, skills development or supplier information.

Collaborative purchasing (Essig 1999, Schotanus 2007) is a concept, which can be applied when organisations have already negotiated best available prices and further reduction is only achievable through increased volume (Figure 20). Competing or complementary concepts are single sourcing or global sourcing. Decisions on collaborative sourcing have a strategic impact because a change of suppliers will have a long-term effect on products, whereas collaborative purchasing only fulfils the immediate requirements. Collaborative purchasing is only meaningful where commonality exists already, whereas collaborative sourcing creates a common supply base.

The scale of potential savings (Kauffman 2001) through a collaborative purchasing hub may lead potential buyers to question the commitment towards collaborative purchasing, in other words without substantial financial benefits there will be no commitment (Sanders 2005, Savasaneril 2004). Compared with private buy-side electronic procurement portals the introduction of consortium purchasing portals increases the probability of reducing item prices and streaming the supplier selection and negotiation process (Bartezzaghi 2004). On the other hand, a supplier has to estimate the ratio between definitively lower prices against higher sales volume.

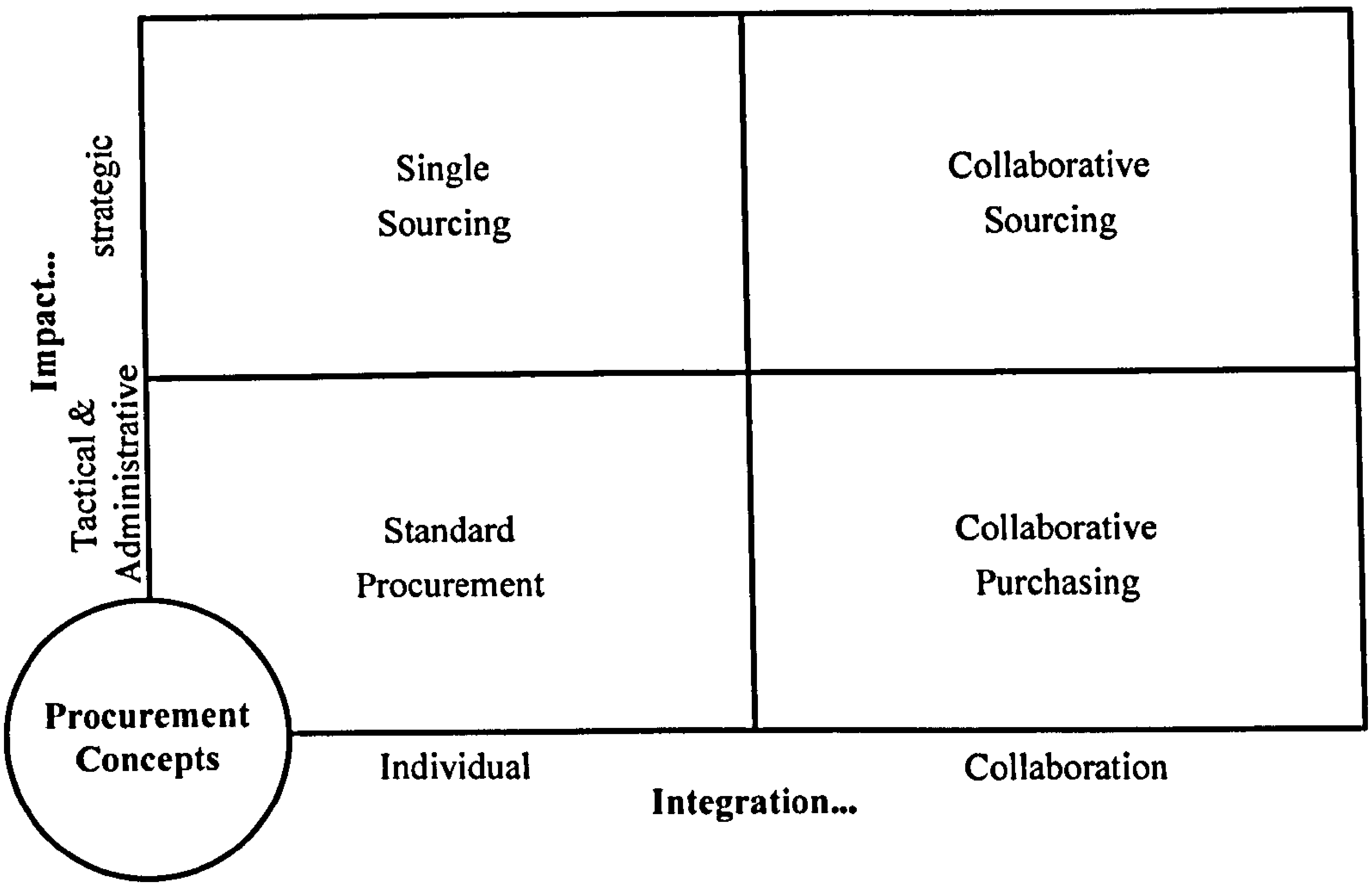


Figure 20: Procurement relation to collaborative concepts (Essig 1999, Schotanus 2007)

With large multinational enterprises, there is certainly an anti-trust issue (Schotanus 2005) to prevent cartels or monopolies, but for SMEs, the issues are mutual trust and deviation from current internal standard procedures. Each collaborating company has to share information about future purchases at a certain point. Even with no direct competitors in the collaborating consortia this data could be potentially misused (Huber 2002, Morrissey & Pittaway 2004). However, collaborative purchasing consortia are predominantly used in horizontal markets across different industries (and most likely indirect materials) rather than vertical markets (Gray 2003, Hendrick 1997). Here, most likely buyers from a particular industry procure direct materials, which is even more difficult because actual products are affected. Hence collaborative purchasing is a hybrid network between market and hierarchy because companies continue with their own manufacturing, marketing, R&D but replace certain control of their purchasing processes by hierarchical collaborative steering (Figure 21).

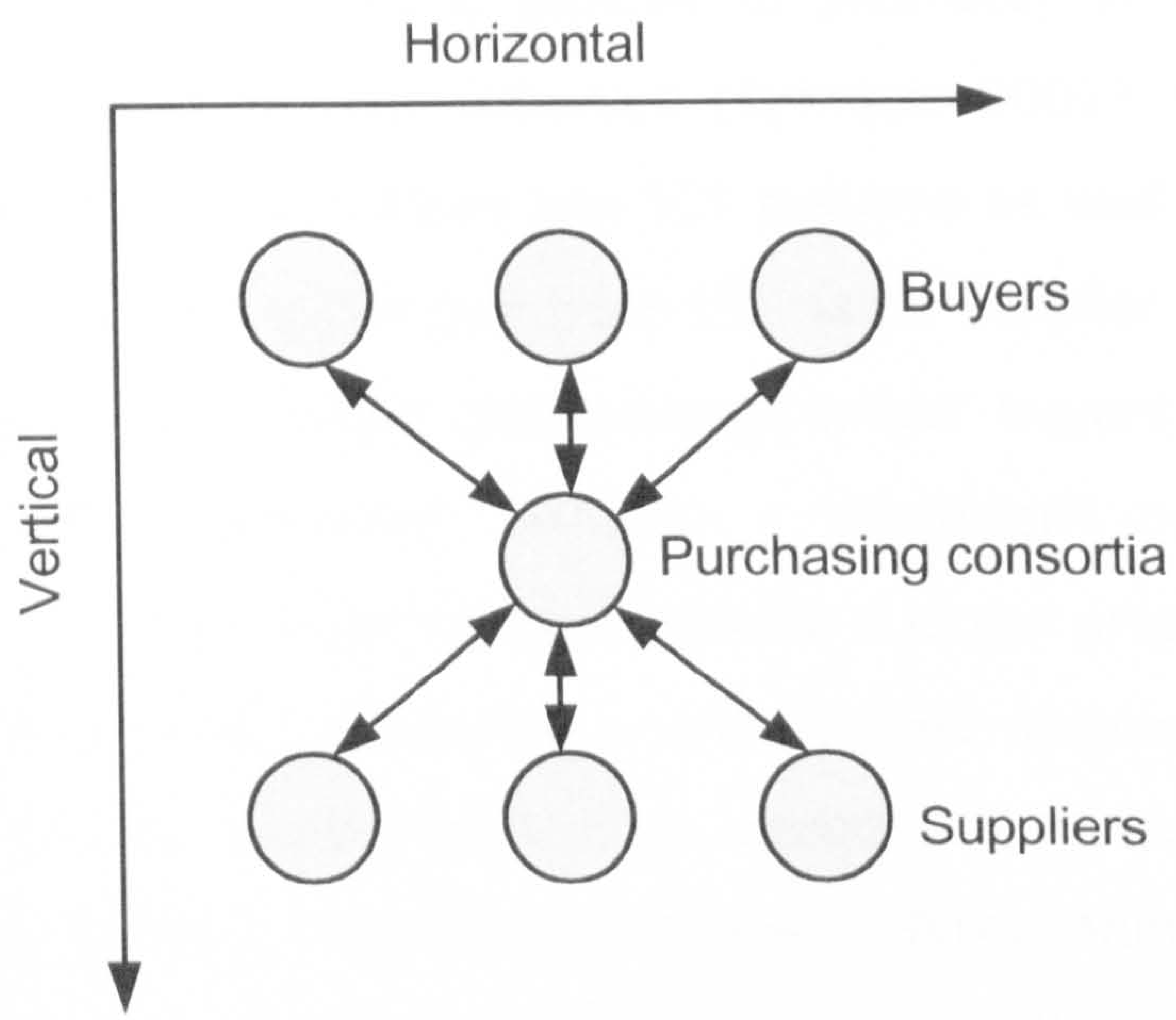


Figure 21: Purchasing consortia (Vertical & horizontal form)

An extensive amount of research, in particular with emerging ICT, in the past decade was targeted towards collaborative purchasing (Alyesworth 2003, Arnold 1996, Essig 1999, Gray 2003, Kivisto et al. 2003, Schotanus 2005) but most of it is related to the public sector (especially hospitals or libraries) (Sickinger 1996) and vertical supply chain collaboration (automotive and aerospace industry). Existing group buying market places in industry seem to be opportunity driven, suitable for spot sourcing but not for the steady and systematic satisfaction of supply needs of the business. The few already existing consortia (Hendrick 1997) work mostly as non-profit organisations run by member companies and limiting areas to MRO goods - 54% of the respondents participating in a buying group, services (46%) or capital goods (35%) but also direct materials (42%) are bought in collaboration. The collaboration with competitors is not considered as a threat if the process of joining of new members within this project is "by invitation only".

Finally, suppliers have to co-operate as well. From the standpoint of an intermediary, this is difficult to promote, as the main driver for buying companies is cost reduction (Eyholzer 2002). However, suppliers have to adopt their processes and ICT systems as well. Also, companies within the consortium might buy from the same supplier at different price levels; an equal price might disadvantage larger buyers (Heijboer 2003, Schotanus 2004). Companies bringing a significant purchasing weight into the consortium might insist to receive a larger proportion of the benefit, on the other hand, presuming a multifaceted structure in the consortium, each company could benefit from individual purchasing power in different areas (Gray 2003, Morrissey & Pittaway 2004). Another possible scenario occurs when large enterprises take smaller suppliers or partners into a consortium deliberately allowing them to participate in group agreements with the aim to improve and control the entire supply chain (Schotanus 2007). Furthermore, an agreement on a base price and the manual data collection seems only feasible for a one-off purchase not for recurring demand (Anand & Ravi 2003). In this case, a volume related discount for individual companies should be negotiated. Another option for rewarding input is to request a deliberately different price for the organisation conducting the negotiation and providing the technical expertise (Schotanus 2007).

Table 2 summarises the advantages and disadvantages of inter-organisation collaboration in procurement (Doucette 1997, Hendrick 1997, Johnson 1999, Nollet & Beaulieu 2005, Rozemeijer 2000, Schotanus 2007, Tella & Virolainen 2005).

Positive Attributes

- Aggregate demands;
- Reduce number of transactions;
- Reduce tender process time;
- Share purchasing expertise, information, ICT and resources to decrease risk;
- Develop best practice and learn from each other;
- Specialisation in purchasing of typical products;
- Standardising and harmonising procedures;
- Expand the cooperation along the supply chain;
- Reduced inventory possible;

Negative Attributes

- Business priorities of individual members are towards income generation, order fulfilment and new product development;
- High individual SMEs workload preventing involvement / commitment;
- Cost of communication / data collection;
- Decomposition of tasks;
- Management / coordination of purchasing workflow across multiple organisations;
- Difficult monitoring and conflict resolution in case of a non-performing partner;
- Initial necessary change of specifications and suppliers;
- Division of gains under consideration of the volume / unfair distribution of benefits;
- Risking disclosure of sensitive information;

Intangible

- Supplier and employee reluctance or opportunism / lack of commitment;
- Loosing (local) existing relations with (small) suppliers through short-term benefit orientation;
- Fear of 'parasites', and dealing with anti-trust or legal issues;
- SME's thriving for independence and autonomy;

Table 2: Advantages and disadvantages of collaborative purchasing

Considering the above, a realistic period for the implementation of collaborative procurement consortia will not be less than one year (Doucette 1997, Hendrick 1997). The estimation of potential savings is about 13% (Heijboer 2003) and considering the cost for the consortium this is giving a return on investment (ROI) of up to 700% (Hendrick 1997). This is even more alluring considering savings in procurement increase the bottom line profit by a much higher magnitude than increased sales, for example, 0.5% procurement cost reduction are equivalent to 10% sales increase (Arnold 1997).

The process of purchasing normally involves two or more parties – with or without collaboration – and access and exchange of information are crucial success factors. That is why, additionally to current best practices an increasing proportion of the procurement process will be ICT enabled. Furthermore, areas like procurement of contract labour, which are conducted in the conventional way, will be e-enabled too (Brousseau 2005).

2.4 ICT FOR COLLABORATION & PROCUREMENT

Information technology is an important aspect supporting collaboration (Wang 2005) in particular in the field of procurement. Compared with paper or human based information exchange, using modern ICT the amount, range and intensity of the exchanged information will multiply. Both working process time savings (Davila et al. 2003) and execution depend crucially on the ability to automate, collect and exchange relevant information. Unfortunately, this is again related back to trust issues and includes a variety of different business software packages on buyer and supplier sites.

Although most standard business software solutions have an interface to export/import data from procurement processes, most SMEs procurement work is still paper-based (PriceWaterhouseCoopers 2000). According to CBI (CBI & KPMG Consulting 2002, Quayle 2003) only one in five companies in the UK purchases over 5% of their total purchases online, similarly 16% of Swiss companies use e-commerce solutions to sell their products (Eyholzer 2000). However, most surveys are conducted using large and medium sized companies, the actual take-up within SMEs is very low to date (Morrissey & Pittaway 2004). It is easier and cheaper for companies to use human readable forms of communication (such as fax and emails), rather than purely electronic data interchange.

With regards to collaboration in electronic procurement, it implies at least two parties to be involved - one buyer and one seller - most likely with different and incompatible ICT solutions. Procurement, collaborative or individual, is part of software packages that support the workflow within a company. Although EDI technology (Electronic Data Interchange) has been available since the 80's its costs and complexity compared with benefits prevented the broad use for most of the SMEs (Brandel 1997, Puschmann & Alt 2005, Svensson & Barfod 2002). However, the foundation for "e"-procurement were EDI interfaces of ERP systems (Gebauer 1998). Later the first generation of e-procurement systems emerged, basically empowering the requester to conduct many steps of the procurement process himself by using multi-vendor catalogue databases and an electronic authorisation process (Neef 2001, Wyld 2004). A relevant starting point for this research can be considered as the group buying web portals emerging in the mid-late 90s (Poirier & Bauer 2000).

Many of the web based enterprises disappeared with the speed with which they emerged but they nonetheless contributed towards technology evolution, which is one pre-requisite for state of the art collaboration in procurement today: the need of SMEs to observe demand information on the Internet in real time (Attaran 2001). With ADSL (Asymmetric Digital Subscriber Line) broadband technology as an industry standard today (EUROSTAT 2005), even the smallest company can also afford an in-house web server. The volume of e-business via the Internet is increasing continuously (National Statistics 2006) but it seems that the actual integration of e-business into the core business workflow of SMEs is very low. Even large companies started collaborative purchasing initiatives only in the beginning of the 90s (Hendrick 1997) and the decentralisation of the purchasing function with the related business culture is considered the main obstacle (Puschmann & Alt 2005). However, this decentralisation meshes with trends of employee empowerment and increases in cross-functional teams (Carter 1996).

Information technology is a very fast moving area and is subject to rapidly changing fashion and terminology. This can lead to premature uptake of technologies and hence unstable and expensive implementations. Fortunately, the take up within industry very cautious (Zheng et al. 2004). ICT has, from a business strategy perspective (Levy et al. 2001), for most SMEs only a supportive function. ICT is considered as a means to reach an end and not an end by itself.

From the perspective of collaborative procurement utilising inter-organisation information systems (IOIS) (Humphreys et al. 2001, Kornelius 1999, Morrell & Ezingeard 2002, Pant & Ravichandran 2001) there are three very important main parts:

- Security: All participants - clients and servers - representing an IOIS should be situated behind firewalls. Additional security can be achieved using Virtual Private Networks (VPN) or Secure Socket Layer (SSL) certificates on the server. Of course, no anonymous access can be granted and all users have to authenticate, user name and password should not be transferred in plain text but encrypted.

- Data exchange standards: Initially the information will be handled on a web server but with increasing transaction volume, an automated data exchange will become necessary. Therefore, data standards like XML, RosettaNet, ebXML have to be considered.
- Flexible software development: In the light of different and changing requirements for individual companies, a fast and flexible development platform is crucial. There are hardly any other systems beside Microsoft Windows operating within many SMEs (see ICT Survey Appendix C) and for this research, the decision was made to use Microsoft DotNet technology.

For the scope of this research, the last decades are summarised in Figure 22. From the perspective of an intermediary consortium, ideas how to develop inter-organisation business execution software are developed in Chapter 5, especially considering purchasing.

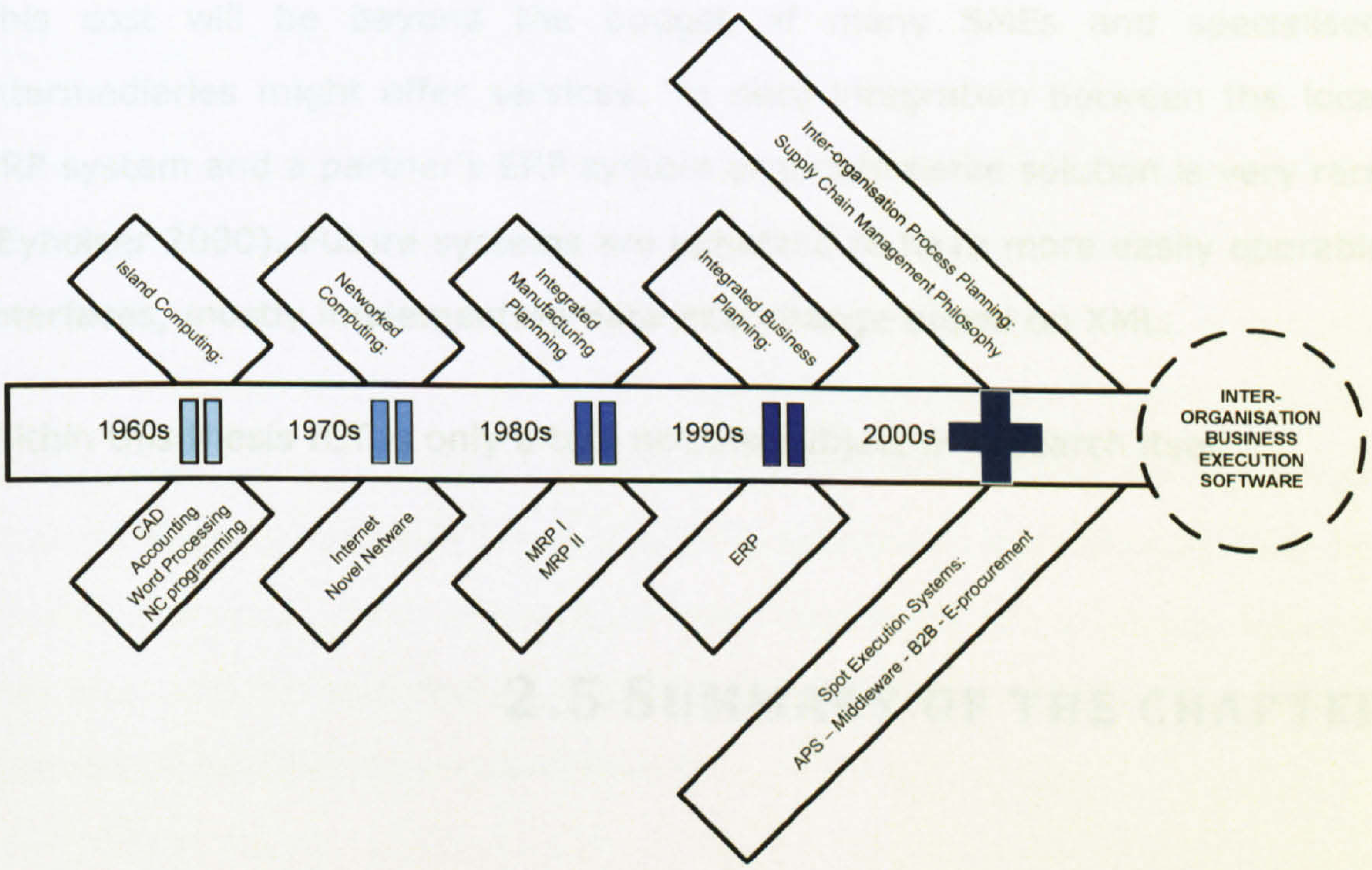


Figure 22: Future of business execution support software

Another important factor for collaboration is the ability to exchange information between different business software packages, such as Sage, FrontStep or Epicor. Compatibility is implemented into these systems much better than ever before (Alshawi et al. 2004, Tarn et al. 2002). When exchanging information (Porter 2000), the content has to be readable for all sites involved. With XML, a common flexible standard is available, but the semantics will differ in each system. Here, data translation is still necessary, for example, using MS BizTalk Server.

Within MS BizTalk Server the contents of business processes is not covered, neither the structure, for example, of an engineering change document. MS BizTalk Server can be considered as a "transaction engine" using another framework like RosettaNet (Elting 2002, RosettaNet 2004) or ebXML (ebXML 2004, Mintert 2002, Steger-Jensen & Hvolby 2002) for document definition and, for example, SCOR for business process modelling.

This cost will be beyond the budget of many SMEs and specialised intermediaries might offer services. To date integration between the local ERP system and a partner's ERP system or e-commerce solution is very rare (Eyholzer 2000). Future systems are expected to have more easily operable interfaces, mostly implementing data interchange based on XML.

Within this thesis ICT is only a tool not the subject of research itself.

2.5 SUMMARY OF THE CHAPTER

The main concern of this thesis is to research and subsequently advance the formation of a collaborative electronic purchasing consortium. As a structured approach, this is broken down into chapters with associated research objectives related to individual SMEs purchasing function (Chapter Four), ICT enabling collaboration (Chapter Five), collaborative electronic purchasing prototype software development (Chapter Six) and the advance in collaborative activities constituting a consortium of SMEs (Chapter Seven). Research objectives should specify the system, its users, the environment, and the task. Hence, the aim for this thesis is to:

Develop a framework for SMEs on how to establish electronic procurement collaboration.

Chapter Two summarised trends and challenges in the area of electronic procurement collaboration concluding with the research objectives below. Subject of the following Chapter Three is to discuss and identify suitable methods to answer these research objectives.

Main purchasing function is to supply the company with goods and services to fulfil customers' requirements. In case of a purchasing consortium, depending on the offered products/services, customers and type of markets there are expected differences in the realisation of the purchasing workflow. Before attempting to connect individual SMEs electronically and aggregate their purchasing demands the purchasing process of an individual SME has to be examined. This will outline the alignment of strategic business priorities of SMEs with the purchasing function. The research will develop a framework for SMEs to improve their procurement function.

Chapter Four Objective: What are the necessary considerations regarding the purchasing function within an individual SME?

Major efforts in the past were made to fuse together specialised ICT island solutions within a company, for example MRP (Material Resource Planning), MRP II (Material Requirement Planning), payroll, warehousing solutions. This has resulted in a broad deployment of ERP systems, which are utilised by many SME to run internal business processes. Research is needed to overcome these "SME islands" and to form supply chain networks, especially investigating the integration of collaborative procurement processes into internal business workflow processes. This vast diversity of ICT solutions makes the implementation of IOIS very difficult and the problem is perceived as a major factor in the low take-up of e-business amongst SMEs in general.

Chapter Five Objective: What are the considerations for a non-profit intermediary consortium to deploy the necessary ICT infrastructure to support the collaborative procurement process of a group of SMEs?

Recent developments in ICT based workflows have led to new possibilities in collaborative manufacturing with procurement as a very important part. This is because of an ongoing trend towards outsourcing non-core business processes, which have to be procured, incorporating core suppliers at a later stage. Hence, SMEs find themselves in an ever-growing network of partners. Only the efficient utilisation of modern ICT guarantees a position within a competitive supply chain. The purpose of this research project is to establish collaborative electronic procurement amongst organisations with similar demands at horizontal level. The key co-ordination task within supply chain collaboration is to focus the group of independent organisations aim towards a common goal, by developing mutual interests, synchronising independent processes and standardising data formats. These tasks have to be supported by an inter-organisation information system (IOIS) as an intermediary.

Chapter Six Objective: How can a group of SMEs realise a collaborative electronic purchasing process?

Within this research the successful demonstration of the development of a collaborative consortium is given, exemplified in particular related to the subject of purchasing. Trends such as increased outsourcing and globalisation seem to underpin that the development of collaborative networks in general will become a crucial success factor for the business survivals of SMEs in the future.

Chapter Seven Objective:How can a collaborative consortium develop over time and what is necessary to succeed?

3. RESEARCH METHODS FOR COLLABORATION IN PURCHASING

Chapter Two presented a state of the art literature review outlining the main problems and identifying gaps in previous research to be addressed in this thesis. Considering the research objectives of section 2.5, this chapter describes the research methods applied to approach the research problem of developing collaboration in purchasing.

3.1 RESEARCH PHILOSOPHY AND RESEARCH METHODS OF THIS THESIS

Research is a journey, which literally means to "search again - and again". It is an activity based on intellectual investigation aimed at exploring, describing or explaining knowledge. The following part of this chapter attempts to give a systematic overview of research methods as considered appropriate for this thesis (Perry 1998). Suitable and in the context of this thesis applied concepts are emphasised. The negligence of non suitable concepts is justified.

3.1.1 Research Strategy

The strategic goal of research is to produce new knowledge by exploring, describing or explaining (Reynolds 1971, Yin 1994). Exploratory research aims to observe a phenomenon and to develop suggestive ideas (Reichenbach 1938). The design of the research should be as flexible as possible; the purpose is to build theory. Subsequently, descriptive research can be carried out to develop further empirical generalisations that were omitted in exploratory research. Explanatory research is often related to observing with subsequent analysis and interpretation (Sen 1980). Explanatory research develops explicit theories evolved from and aiming to explain empirical generalisations of descriptive research. This provides a cycle of research theory construction, testing and reformulation (Peecher & Solomon 2001).

3.1.2 Research Philosophy

In the context of research, a philosophy holds the beliefs about the way how data or information should be gathered (Davison 1998). A scientific philosophy is a set of basic assumptions based on beliefs about the nature of realities and their truth or falsity is not subject of empirical testing (Hirschheim 1992, Hirschman 1986, Lincoln & Guba 1985).

Inductive (empirical) research starts with an observation (Chalmers 1978, Keys 1991) . Theoretical sampling is the process of establishing the number of cases needed that represent different aspects of reality (Glaser & Strauss 1968). With the collection of sufficient evidence generalised statements such as theories and models can be induced. Problems of inductive research are the dependency of observations from presupposed knowledge and the issue with "sufficient" empirical evidence. To overcome these a new view was developed mainly by Popper known as falsificationism (Popper 1959). In his view a hypothesis can never be proven true, it can only be proven wrong (falsified). But the more falsification attempts fail, the more credible the hypothesis is.

For deductive research observations are made to confirm a given (theoretical) construct (Bryman & Bell 2003, Do et al. 2006). It involves the development of a model: a simplification of reality. Models can be seen as mediators between theory (symbolic world) and observation (real world) (Morgan & Morrison 1999).

In contrast to natural sciences, when researching an organisational managerial phenomenon, there is no objective reality (Knudsen 2003b, McKay & Marshall 2000). The perceived reality will differ from individual to individual based on cultural background, believes, experiences in life and motivation related to the subject. Hence, words and actions of participants represent the data of a qualitative research; they deliver by means of language the social and cultural context (Gummesson 2000).

A data collection method can be classified into primary and secondary (Myers 1997). Primary data sources are unpublished to date and gathered by the researcher. Secondary data sources refer to any previously published materials. Further, the sources of evidence can be divided (Yin 1994) into documentation, archival records, interviews, direct observation, participant observation and physical artefacts.

Another difficulty is the interaction between researcher and observed phenomenon (Benbasat et al. 1987, Hoepfl 1997). This has been challenged with the emerging quantum mechanics. However, in natural sciences the experimental conditions are many times reproducible regarding parameters such as time, space and researcher. In real world business environments variations of variables and their relations cannot be experimented (Westbrook 1995). Managerial research can be positioned between natural sciences and social sciences; human interactions are an integral part but not the focus of research. When researching managerial real world issues the researcher is often directly involved (Gummesson 2000, Kemmis & McTaggart 1988). Also, with time progressing and developing experiences of involved participants the experiments are hardly repeatable. Human beings and business context are unique; additionally customers and competitors cannot be controlled (Kock et al. 2000).

3.1.3 Research Methods

A method in the context of a research project is considered as a series of steps taken to acquire knowledge, it is a strategy of inquiry moving from the underlying philosophical assumptions towards research design and data collection (Myers 1997); whereas a methodology is understood as the multi-dimensional analysis of the principles and methods, rules, and postulates employed by a discipline. For the purpose of this thesis the applied research methods are the tool and not the subject of research itself.

The chosen research method influences the way in which the research data is collected (Gummesson 2000). The most common approach to classify research methods is into qualitative and quantitative (Robson 2002). Quantitative research methods originate from natural sciences to study natural phenomena and their relations by using numbers and measurable evidence. A controlled laboratory experiment is considered an ideal method to explore variables and their relations (Chen & Hirschheim 2004, Claver et al. 2000, Levitt & List 2007). "Qualitative research is an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyses words, reports detailed views of informants, and conducts the study in a natural setting (Creswell 1998)." Common qualitative (interpretism) research methods (Galliers 1992) do not provide the same level of control compared with experiments used as a quantitative (Positivism) method (Table 3). The variation of variables can only be achieved in environments controlled by the researcher (Scandura & Williams 2000). However, exactly this ability to flexible incorporate unknown boundaries and variables is the strength of qualitative research methods such as case studies and action research (Benbasat et al. 1987, Chen & Hirschheim 2004).

Positivism	Interpretism
- Laboratory experiments	- Subjective/argumentative
- Field experiments	- Reviews
- Surveys	- Action research
- Case studies	- Case studies
- Theorem proof	- Descriptive/interpretive
- Forecasting	- Futures research
- Simulation	- Role/game playing

Table 3: Taxonomy of research methods (Galliers 1992)

Other approaches to classify research methods are: (1) empirical vs. non-empirical – empirical studies rely on observations and data whereas non-empirical emphasises ideas and concepts; (2) Cross-sectional vs. longitudinal – the longitudinal approach measures the same phenomenon at different times, a cross-sectional method requires a snapshot measurement at one time (Claver et al. 2000, Hirschheim 1992).

For the research of managerial issues in collaborative purchasing and their development at the same time the use of two research methods is in particular suitable and discussed as follows (Creswell 1998, Gummesson 2000, Myers 1997, Silverman 2005, Wolcott 2001).

Case studies aim to draw general conclusions from a number of limited cases with many very complex variables by interpreting a series of events in a conclusive manner. Case studies are one appropriate research approach to answer the "why" and "how" (Yin 1994):

1. Investigates a contemporary phenomenon within its real-life context, especially when;
2. The boundaries between phenomenon end context are not clearly evident;
3. Copes with the distinctive situation in which there will be many more variables of interest than data points, and as a result;
4. Relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result;
5. Benefits from the prior development of theoretical propositions to guide data collection and analysis.

Case study research is based on multiple sources of evidence (Yin 1994) in a real environment and cannot be planned completely beforehand (Knudson 2003, Remenyi et al. 1998) as the researcher has limited control over the outcome. They serve the purpose of exploring contemporary issues by developing new or expanding theory. Hence, case studies are suitable for providing a description, testing theory and generate theory from practice. Academic criticism of case studies as an scientific method can be summarised (Gummesson 2000):

1. Lack of statistical reliability and validity;
2. Generation of hypothesis without testing them;
3. Generalisations cannot be made based on case studies.

A project of the complexity of this thesis cannot be conducted with standard quantitative research methods; the number and complexity of variables are too high and not controllable. Additionally, traditional case studies can be carried out to the wish of the researcher, provided that data is available.

However, if a change or implementation process is needed case studies are not suitable.

Action Research is the combination of research and management consultancy that involves intervention into processes of decision making, implementation, and change (Dick 1997, Gummesson 2000). Action Research is the reflective process whereby in a given problem area, where one wishes to improve practice or personal understanding, inquiry is carried out by the practitioner first, to clearly define the problem and secondly, to specify a plan of action including the testing of hypotheses by application of action to the problem. Evaluation is then undertaken to monitor and establish the effectiveness of the actions taken. Finally, participants reflect upon, explain developments, and communicate these results to the community of action researchers. Action research is systematic self-reflective inquiry by practitioners to improve practice, the study of activities and the effect of these in a workplace environment (McNiff & Whitehead 2000).

Hence, action research as a method is scientific in that it changes industrial practice and observes the effects through a systematic process of examining the evidence. Action research is an experiment in design by trying an action and subsequently learning about the consequences and developing theory about the action. The aim is to improve the quality of practice (of activities) of academics and practitioners (Bourner & Simpson 2005, Whitehead 1994). Hence, action research is most likely inductive theory building research. The involvement with practitioners into matters of real concern to them provides a richness of insight which would not be gained otherwise (Eden 1996).

Action research entails deliberate cycles (Figure 23) of planning, acting, data collection through observations, interviews, questionnaires and reflecting (Stringer 1996). Hence, action research is not repeatable experimentation; each intervention will be different from the last. Through cycles, action research generates emergent theory, which is developing from a synthesis of practice and intervention on one side towards abstract generic models or frameworks (Eden & Huxham 1996).

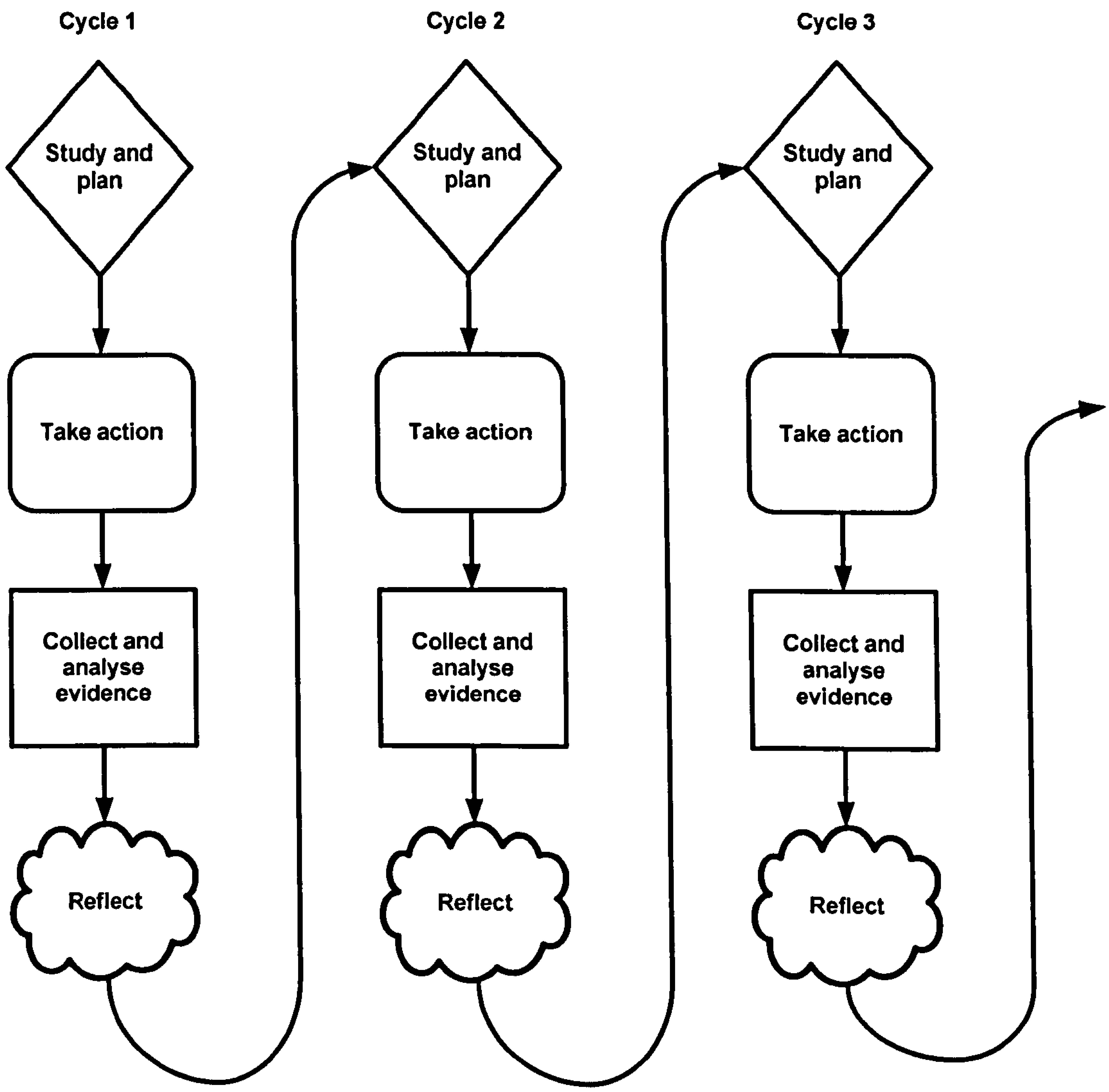


Figure 23: Action Research Approach (Stringer 1996)

Action research inherently involves the participation of practitioners. The concept of distinguishing between research "on" people and research "with" people – sometimes referred as participatory action research (Breu & Hemingway 2005) – is not followed in the context (Coughlan & Coghlan

2002, Eden & Huxham 1996) of this thesis as action research constitutes only one tool and not the subject of research itself.

3.2 RESEARCH APPROACH OF THIS PROJECT

An engineer is a person who solves practical problems, in this case by applying modern ICT within context of a collaborative consortium. One of the main objectives of information systems (IS) research is to "make a difference", to impact the life of IT professionals and IT users in efficacious ways (McKay & Marshall 2000). This paper, an academic thesis in engineering, aims to abstract problems in the field of collaborative purchasing by developing a model and framework to reduce and factor out details so that one can focus on a few critical concepts at a time. By developing a consortium, this study also sought to unravel empirical evidence and generalise. The origin of the word "empeiria" is Greek and means: knowledge based on experience and observation.

Activities within this project range from IS design, programming, ICT implementation, to business process co-ordination, networking, and development of trust/commitment within a consortium. Decisions about the methodological approach applied in this thesis are summarised in Figure 24 and discussed further below.

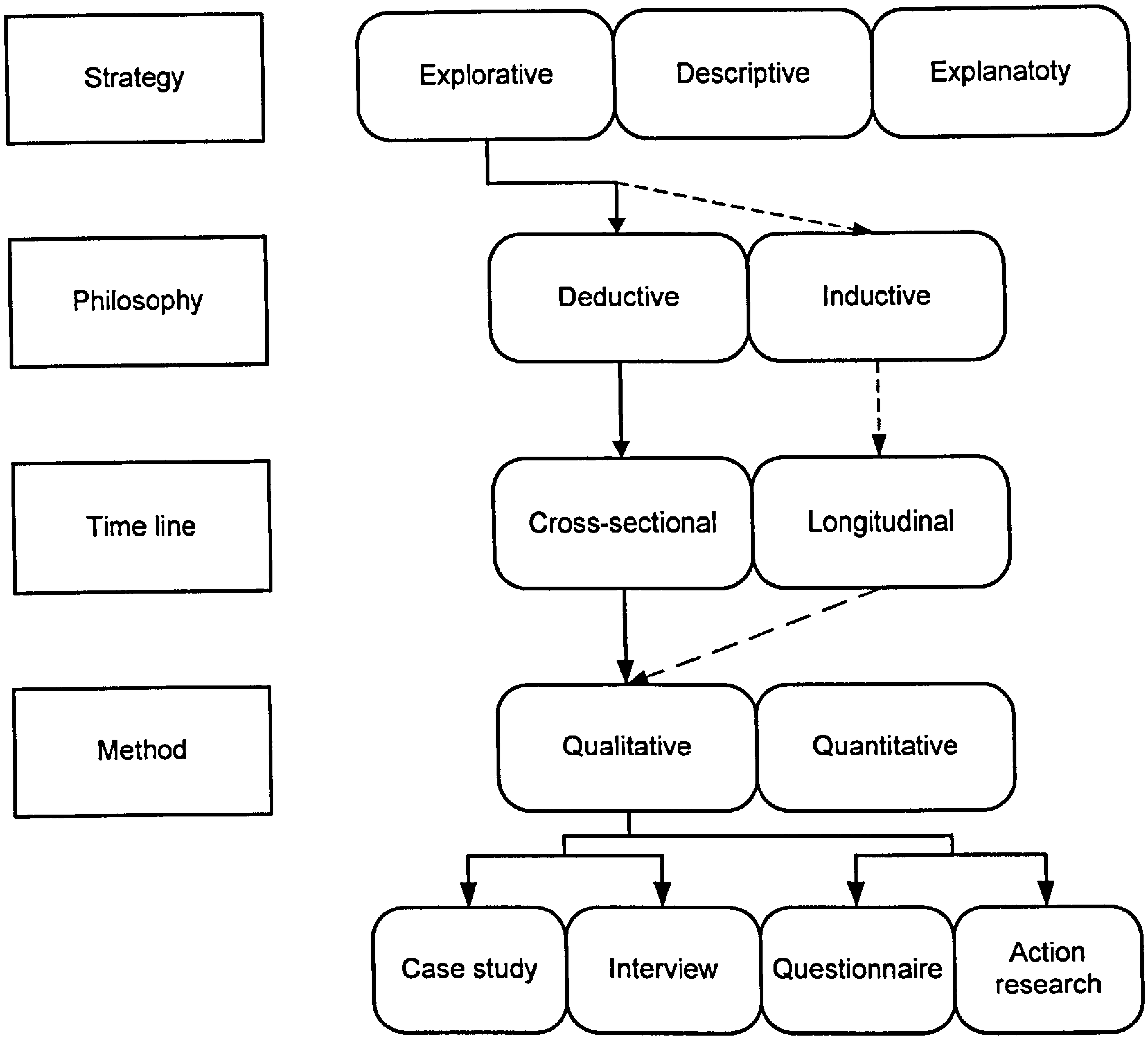


Figure 24: Research approach applied for this thesis

Basic question from a research strategy perspective is: How does this thesis produce new knowledge? As suggested in the state of the art review, supply chain management theory with purchasing as an essential part mostly relates to large organisations. With little information available specific to SMEs this area needs to be explored. Therefore, the research method "action research" seems to be the best approach to gain privileged access to necessary resources to conduct the managerial research (Eden & Huxham 1996, Gummesson 2000, McArdle & Reason 2007, Perry & Zuber-Skerritt 1992, Sankaran et al. 2006) and in turn deliver tangible benefits the consortium to maintain a high level of interest throughout the project duration. It can not necessarily be expected that this organisation is concerned with the general research subject but with a practical solution (Eden & Huxham 1996). Hence, as suggested for a case study approach (Yin 1994), the prior theoretical proposition "purchasing framework for SMEs" will guide the data collection and analysis.

When starting this project electronic collaboration would not have been possible to the intensity as discussed throughout this thesis; firstly, trust and commitment within the consortium need to develop and secondly, the author needed to explore the research field. Thereby, the author has identified three important areas to consider within the literature review: purchasing and supply chain management and information technology for collaboration.

In addition to this comprehensive literature review (Chapter Two) the purchasing framework for SMEs has been developed. The purpose is to enable participating organisations to understand the complexity of organisational relations and to align their purchasing function with those of other members of the consortium. The purchasing framework for SMEs is thoroughly explained in Chapter Four. As no dominant paradigms and theories exist in purchasing management (Das & Handfield 1997), from a research quality view point Chapter Four can be considered as exploratory for SMEs triangulating (Mangan et al. 2004, Scandura & Williams 2000, van Wijk 2003) the validity of the model by comparing with the approach for large organisations.

To increase reliability several exercises in collaborative purchasing were conducted. This framework itself with all variables is too large to be researched in a single project and hence, is later considered in the context of collaboration leading to the collaboration model for SMEs. This deductive approach inducing a framework for purchasing is necessary to operate on a minimum level of mutual understanding both in terminology and purchasing process.

An inductive approach on the other hand would have required to conduct purchasing with each individual company, collect information and develop the collaborative approach. This type of 'field experiment' was considered as unfeasible (Claver et al. 2000, Harrison & List 2004); it would have consumed much more time with participating companies. The possible time commitment of participating companies can be considered as one of the constraints within this research project; hence the less time consuming option is chosen throughout.

At times it was perceived that the field provides a never-ending flow of new innovative business concepts. As a response, trying to keep at the forefront of knowledge is very time consuming and frustrating too - based on the intention to read all relevant information... Nevertheless during the entire project literature study has served as the triangulation method to assure qualitative and valuable research being delivered through constant benchmarking with the state of the art. Existing literature can be used to (Silverman 2005):

1. Stimulate theoretical sensibility;
2. Provide secondary sources of data;
3. Stimulate questions during data gathering and analysis;
4. Direct the theoretical sampling;
5. Be used as a supplementary validation.

However, literature can be biased, depending on the purpose the author was aiming to achieve (Needham 2000). This in particular was relevant as the research spanned the rise and fall of the "new market", related mostly to electronic business systems (Bailey & Bakos 1997, Barnes et al. 2003, Barnes et al. 2004, Razi et al. 2004). The further approach on researching collaborative electronic purchasing within an SME consortium needs to address the problems uncovered within the state of the art review.

It is very complex to design and conduct data collection and data analysis from operations networks (Lehtinen 2001); the researched phenomenon might not be forthcoming all the time. Ongoing research over a few years is not unusual (Lehtinen 2001, Zeng et al. 1999). In the case of this project, seven years of research may seem a long time; this has been however necessary to work with several companies' purchasing business processes with underlying ICT, supply base or to develop trust and commitment towards the consortium. Also, within this research only one consortium is considered. Hence the time line philosophy approach adopted is cross-sectional. A longitudinal observation in the field of collaboration is beyond the scope of a single PhD research project.

A standard quantitative approach is to single out a few factors and study them in detail (Ragin 1987). This approach would have been possible for the narrow field of procurement but would have left many problems unsolved towards a collaborative consortium. Furthermore, the author doubts that a narrow focus on procurement is sufficient to maintain interest and more importantly to develop personnel relations. Only the empirical inductive approach into collaboration guarantees the privileged access (Gummesson 2000, McNiff & Whitehead 2000), which is necessary for conducting case studies and action research.

At the beginning of the project a consortium was just founded; no collaboration took place to a large extent. Hence, neither descriptive nor explanatory research is appropriate in this context. Assuring participation of consortium member companies has been proven very difficult even considering the very "hands on" exploratory approach by using the author as a "catalyst" to improve collaboration. The perceived benefit by undertaking descriptive or explanatory research would have been much lower and similarly would have been the degree of collaboration. Hence, this project involved to a large extend technology transfer into the consortium. This required the author to be a significant part in the implementation process. The application of a positivist, objective and "outsider" research philosophy seemed not to fit the objective. Only an interpretive, subjective and "insider" research philosophy could produce results to measure.

To test the purchasing framework the necessary IT infrastructure for collaboration in purchasing needed to develop (Chapter Five and Six). After the exploration of individual and collaborative purchasing as a business function the area of information technology tools is discussed in Chapter Six. To conduct the purchasing process electronically the IT infrastructure within the members of the consortium was analysed using the methods online survey, informal interviews and the development of the collaborative purchasing pilot software as a tool to proof the concept. Qualitative action research as a the overarching main method was used as this is particular suitable for information systems (McKay & Marshall 2000, Myers 1997). Chapter Five discusses variables of inter-connecting information systems of a group of SMEs from a consortium's perspective. This leads to Chapter Six, which explains the development of a collaborative purchasing software prototype for an SME consortium.

The main objective of this thesis is to research the formation of a collaborative SME consortium in general and in the field of purchasing in particular. Major parts of the work undertaken within this project was adopting action research as the method (Bourner & Simpson 2005) to answer how a collaborative consortium can develop over time and what is necessary to succeed. The viewpoint of the author is from the perspective of the consortium, working as a consultant advising member companies.

The combination of case studies with the action research method allows the researcher to become directly involved by asking "how to" improve questions. Here data collection and analysis is predominately conducted through qualitative methods such as informal in-depth interviews, observation and interaction with participants which are involved into the researched activity but also though a number of collaborative procurement cycles. Action research states several cycles that integrate experience, action and reflection (Reason 1994); after a few successful action research cycles (Glaser & Strauss 1968) the collaborative purchasing software pilot was successive developed to automate repetitive tasks of demand aggregation and deployed as the central hub of the consortium. Where initially the purchasing model for SMEs was only used within the context of purchasing, subsequently it was expanded to identify and implement further collaborative activities.

In this context action is the means to change the world and reflection is used to develop knowledge about it and experience further. The approach of this project is to generate benefits to participant practitioners at the moment of action and beyond by modelling, "frameworking" and systematising (Eden & Huxham 1996). The researcher involved in this project plays the role of a consultant and facilitator (Gummesson 2000), not of the owner of the process (collaboration in purchasing and beyond), adjusting the use of information technology to meet the requirements of the consortium in the best possible way.

As suggested in literature (Coughlan 2002, Perry 1994, Stringer 1996) there should be a distinction between the success of the action research core project in the real world and the project submitted for an academic degree contributing towards the knowledge in the field. Bringing together the SME purchasing model and the collaborative ICT test implementation software, action research was merely undertaken to validate. This was investigated in a series of collaborative purchasing initiatives and the development of a collaborative consortium in general. The result of various action research cycles is the collaboration model for SMEs.

The distinction between academic researcher and business management consultant becomes blurred. An interesting differentiation is made as follows (Gummesson 2000): a consultant contributes to practice backed up by pieces of theory; an academic develops theory supported by empirical data.

In combination, the results of this thesis provide a structured approach for SMEs to develop their purchasing function and to speed the process of developing a collaborative consortium; hence, this thesis is evidence of transferring project based or personnel learning into shared knowledge (Bourner & Simpson 2005).

3.3 QUALITY ASSURANCE IN RESEARCH

Quality of a research can be judged considering the terms validity, reliability, generalisabiliy and credibility (Yin 1994). For managerial organisational qualitative research this is approach is questionable (Hoepfl 1997, McKay & Marshall 2000, Stringer 1996) a decentralised approach depending on the local context is required. Common problem and conflict when assessing the quality of scientific reports is the unconscious inability to distinguish between research designed to generate theory and that to test theories (Hunt 1976) or qualitative research is judged from the vantage point of the quantitative paradigm (Gummesson 2000).

Reliability is the ability to perform a particular action with the same result again. Always, scientific knowledge capture methods will be subject to a number of human factors like bias, subjectivity, probability or uncertainty (Wokutch 1979). The development of a collaborative activities strategy and working processes "depends" deeply on personal skills of individuals; from a perspective of a consortium different individuals will identify different fields of collaboration to coordinate. However, with the development of the purchasing framework (Chapter Four) and the collaboration model for SMEs (section 7.4) established, trackable and documented methods are available (McKay & Marshall 2000). The author's field of expertise relates to IT and engineering unfortunately neglecting fields such as accountancy or human resource management.

The term objectivity refers to applying quantitative measures to define a situation relatively value-free (Hoepfl 1997). To conduct managerial organisational research in an objective and mutually accepted reality is difficult (Gummesson 2000); each individual acts in a subjective reality based on culture, believe, experience or business context. Within this thesis the involvement of more than thirty companies in the collaborative consortium generate a good validity of research, a good refection of a "confirming auditor" (Lincoln & Guba 1985).

The actual research was conducted in a manufacturing environment with a single consortium. This includes the development of frameworks and models from a particular perspective. Ability to use results towards e.g. electronic, chemical or agricultural industry rests with the person acting as the "transferor" (McKay & Marshall 2000). However, the rich description of the research setting (Guba & Lincoln 1989, Kock et al. 2000) in Chapter Seven, many collaborative purchasing action research cycles, continuous observations and triangulation with literature increase the transferability (Kock et al. 2000). Additionally, to generalise the work future research could be investigating collaboration between independent consortia.

Credibility of qualitative research is closely related to the author (Guba & Lincoln 1989). In this thesis "what", "why" and "how" questions are answered related to the formation of a collaborative consortium. Evidence is a multitude of mutual projects and standing working relations.

4. DEVELOPMENT OF A PURCHASING FRAMEWORK FOR SMES

Based on preliminary research, which was predominately investigating large organisations (Aksoy & Derbez 2003, Morrissey & Pittaway 2004, Saunders 1997, Smeltzer 2001, Smith & Buddress 2005), the following considerations draw conclusions to help individual SMEs developing their state of the art purchasing capabilities.

This chapter develops a framework of the procurement function starting from business strategy (Smeltzer & Carter 2001), covering procurement management as well as individual items (Caniels 2005, Kraljic 1983) and related suppliers. Information and required knowledge to align the management, business workflow and culture of individual companies towards enabling collaboration is specified.

This is applicable considering any manufacturing company, which will be part of a supply network. However, most of the considerations in this chapter are made from the viewpoint of a collaborative consortium.

4.1 Motivation

The literature on procurement is extensive and mostly based on individual case studies or surveys, which explains the different positions and contradictions created by a diverse set of opinions and strategies within the subject. This has not changed through this research but rather confirmed, as all participating companies are unique, characterised by their products / services and corporate structure. When researching the current state of the art technology and managerial practice the focus of this research is towards manufacturing SMEs.

Large companies model the entire supply chain (Favilla & Fearne 2005); SMEs need a framework to master their own position. Current generation of ERP systems, implemented by many SMEs, focuses on the coordination of internal processes but does not include seamless integration with external partners. The following (Figure 25) will suggest a framework to shorten this gap applying SCM as the tool to coordinate collaboration. From a purchasing perspective, SCM should be used to link customer demands and requirements with supplies.

Large organisations aim to control the supply chain "end-to-end" across all involved tiers, which is questionable for SMEs with regards to:

- Complexity of required knowledge and understanding of inter-organisation issues;
- Relevance for the own company as many other actors within the supply chain are considered too.
- Accessibility of information.

From the perspective of an individual SME the contribution can only be to link customer requirements (which provide income when turned into orders) and related supplies (Figure 25). The metrics and information for a SCM data analysis to shorten this gap are provided in this chapter. This will be a pre-requisite to participate in future supply chains on a "partnership-level" rather than the "order-receiving" end.

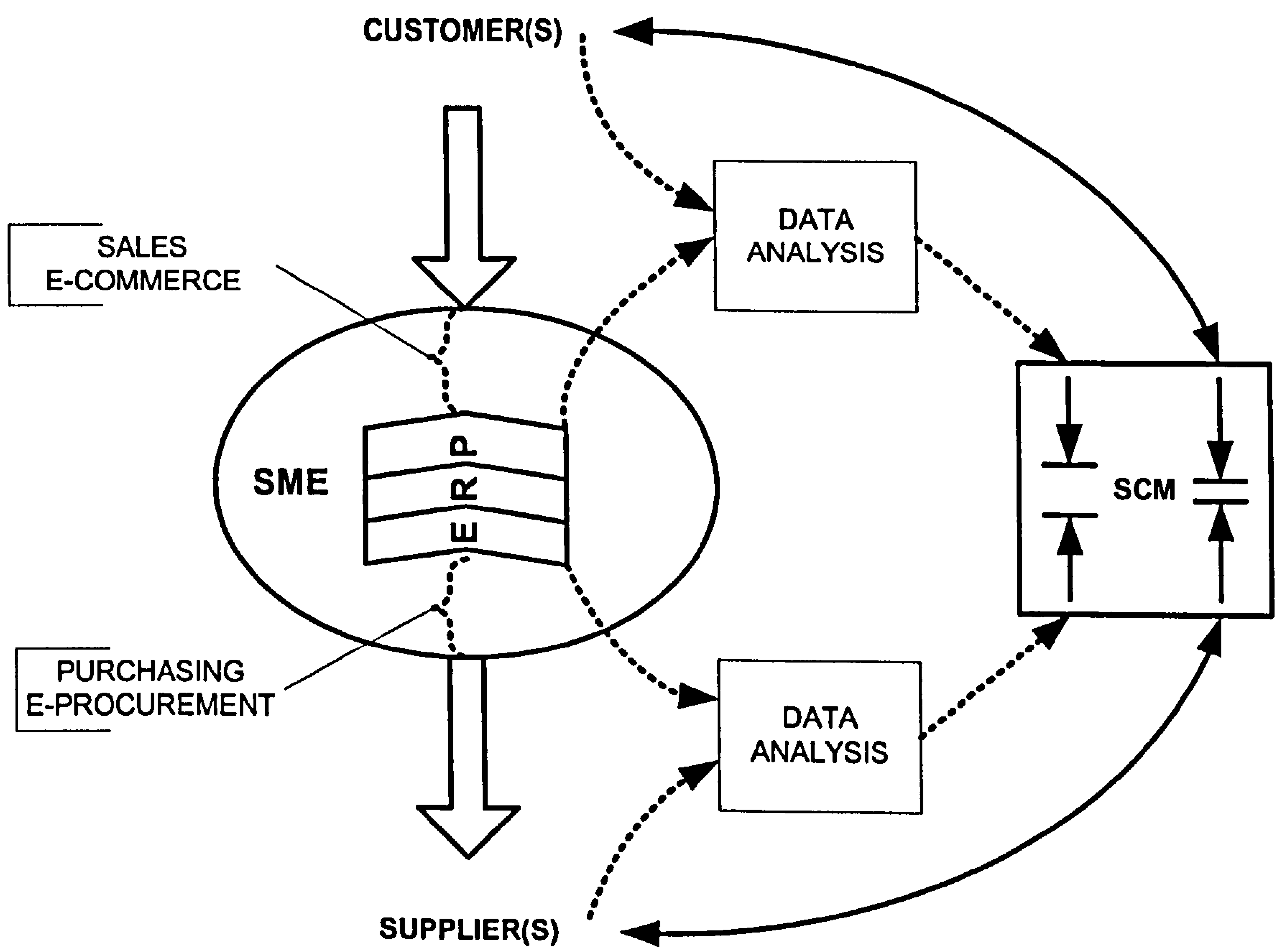


Figure 25: Application of SCM in the context of SMEs

4.2 Business and Procurement Strategy

When forming a collaborative purchasing consortium, the management of participating companies has to promote the idea to get purchasing staff involved. The following is developing ideas relating the purchasing function to the company's strategy to enable the progress towards collaboration. A complete summary on business strategy is beyond the remit of this thesis.

The correct integration of the procurement function as part of the supply chain management into the company's overall business strategy will contribute to decreasing risk and creating opportunities for cost reduction. Because the purchasing function of SMEs has traditionally been considered as clerical (Hughes et al. 2004, Quayle 2002, Ramsey 2001), in the past companies often did not link purchasing with general business strategy. Hence there is often no understanding of how purchasing can contribute to achieving a competitive advantage. Procurement systems and procedures depend on the overall business strategy aiming to secure the company's supply (Figure 26) but many cost reduction strategies of the recent past actually increase risk and probability of failures (Bretzke 2003).

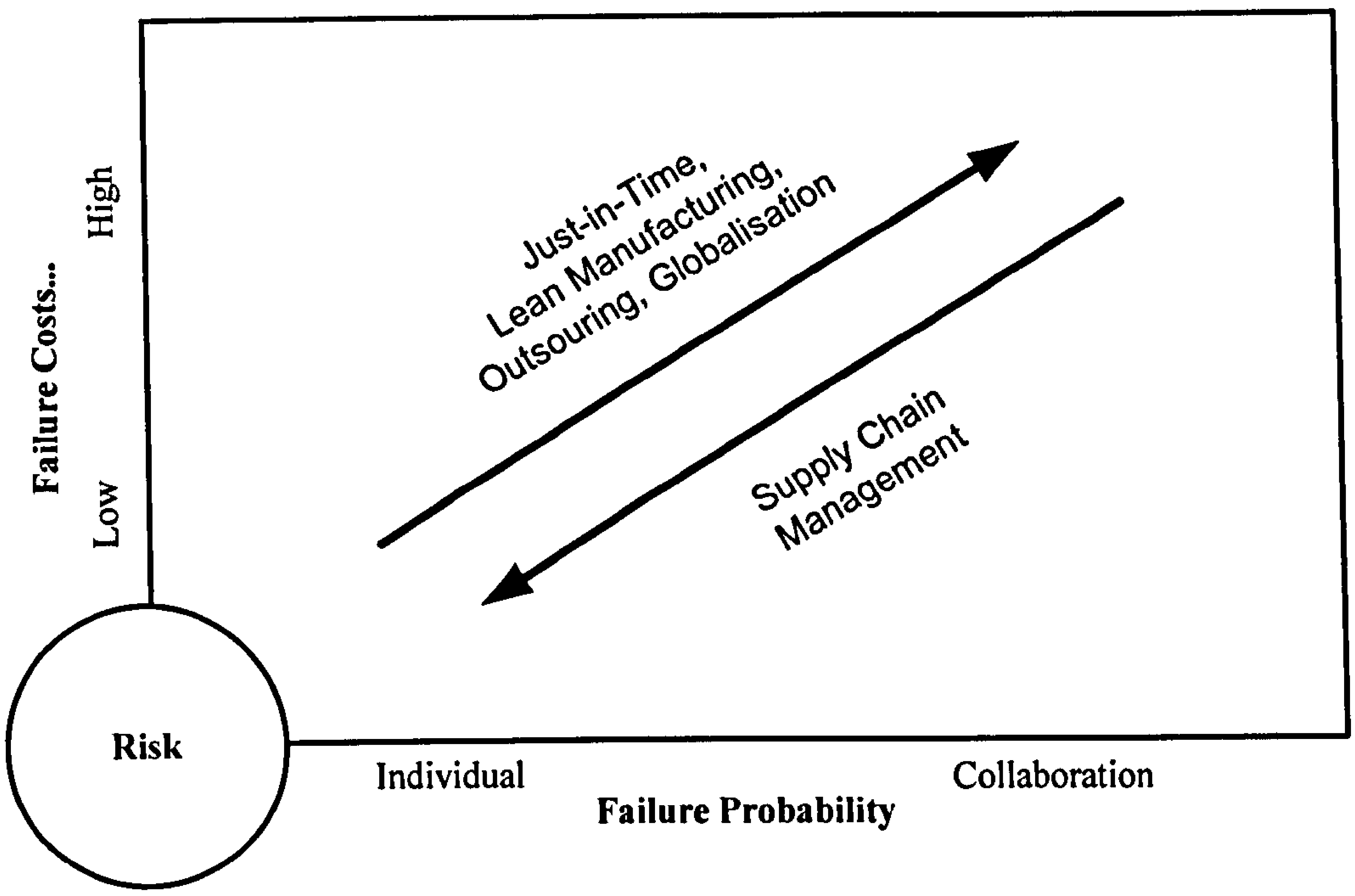


Figure 26: Supply concepts and supply failure considerations (Bretzke 2003)

Business strategy relates to how a company intends to realise their business goals on a long-term basis (COED 2005). The purpose of a corporate strategy is to integrate an organisation's major aims, policies and action sequences into a cohesive goal (Quinn 1980). Strategy is concerned with deploying resources, and related tactics are employed to carry out activities to achieve particular objectives, bridging the gap between ends and means (Grant 1991). Tactical objectives are short-term, measurable and specific whereas strategic objectives are long-term, qualitative and general. Thus, strategy will normally address desired quality values, product & service costs, delivery reliability, responsiveness targets and new product development aims. Hence, aiming towards a profitable business a corporate strategy elaborates the relationships among products and services, customers and markets, distribution and logistics channels.

The purpose of any business including SMEs is to sell products or services on the market, which has to be reflected in the company's strategy and the purchasing function supports the strategy (Bartezzaghi & Ronchi 2003). The Supply Chain Operations Reference-model (SCOR) is a framework for linking strategy with operational execution by evaluating important metrics, relating them to the corporate balance sheet and determining corrective actions (Lambert et al. 2005, Nollet et al. 2005).

From a consortiums perspective, strategy of member companies links manufacturing and organisational capabilities to important organisational priorities, which should include the following (Figure 27) for any existing business:

1. It is of vital importance to generate and maintain a steady incoming amount of orders for current products and services and subsequent increase in revenue by selling more or increasing the prices. Here the focus is on the sales and marketing side of the business by capturing customer data or anticipate future requirements (Johnston et al. 2007).
2. The order fulfilment process is delivering the contractual agreed product or service; operations management with purchasing is – at this point of the value chain - only a supportive and administrative function to assure the supply with required goods and services.
3. New product development (NPD), services or market exploration safeguards the future existence of the business (Handfield et al. 1999).
4. Internal improvements to decrease costs by lower material costs, personnel cost or reduction of waste processes include SCM, Six Sigma and progress within and by applying advanced purchasing methods.

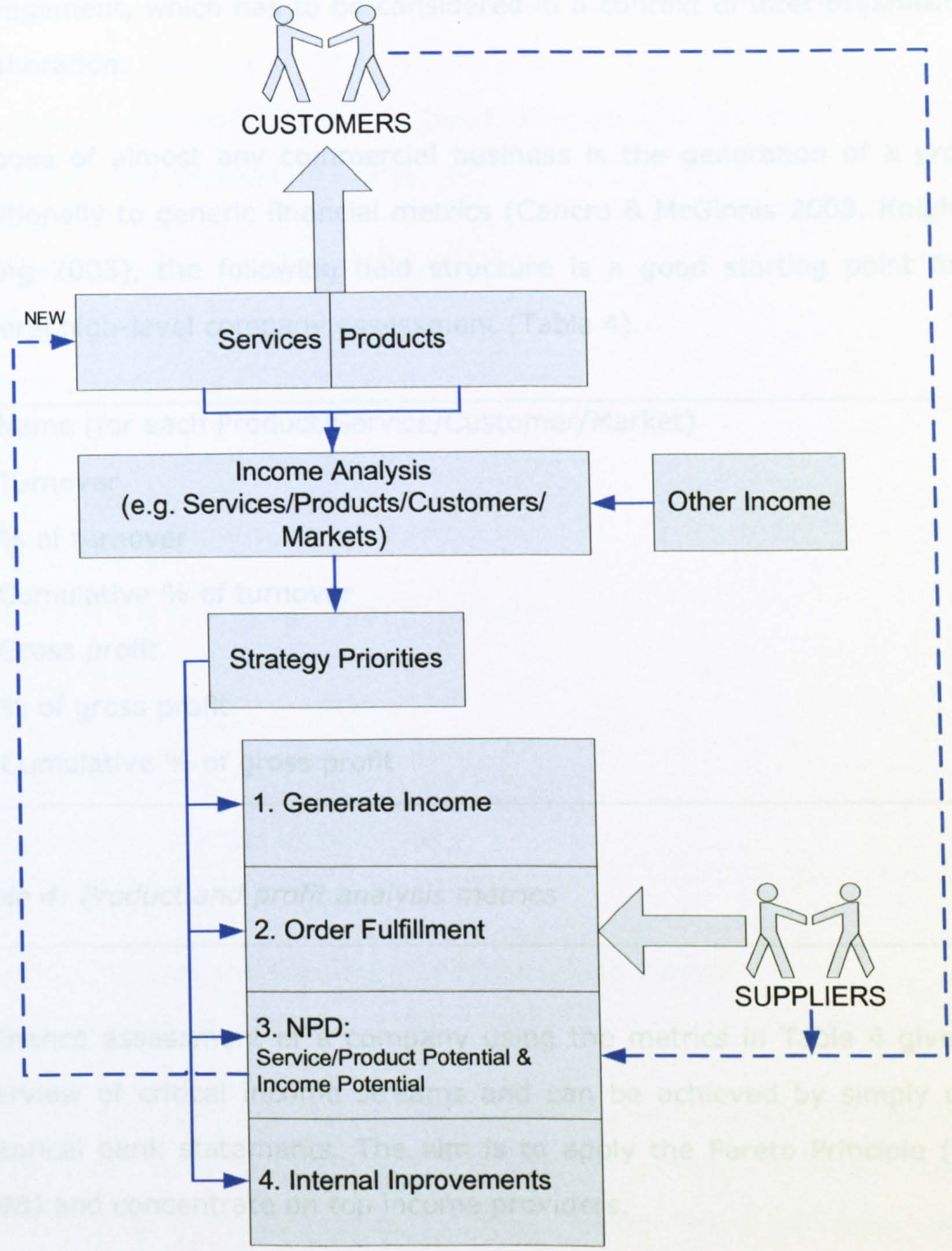


Figure 27: 4-Priorities for collaborative business strategies of SMEs

---

Collaborative networks can influence the internal organisation at multiple levels. Developments in collaborative purchasing usually fall under the fourth priority (Figure 27) within the business strategy of a company (Knight & Zheng 2003). This indicates the low commitment of top management, which has to be considered in a context of inter-organisation collaboration.

Purpose of almost any commercial business is the generation of a profit. Additionally to generic financial metrics (Cancro & McGinnis 2003, Knight & Zheng 2003), the following field structure is a good starting point for a general high-level company assessment (Table 4).

o Name (for each Product/Service/Customer/Market)
o Turnover
o % of turnover
o Cumulative % of turnover
o Gross profit
o % of gross profit
o Cumulative % of gross profit

Table 4: Product and profit analysis metrics

A finance assessment of a company using the metrics in Table 4 gives an overview of critical income streams and can be achieved by simply using historical bank statements. The aim is to apply the Pareto Principle (Koch 1998) and concentrate on top income providers.

To expand this, additional benchmarking (Porter 1996) measures the progress regarding the strategic aims using internal metrics like quality, cost, delivery, flexibility, and innovation. This can be augmented by a competitive strategy that considers differentiation in the customer's eye from competitors via measures such as operational excellence, customer intimacy or product leadership (Nickols 2003, Porter 1980).

With this knowledge, the following field structure (Table 5) is a good starting point for product/service assessment and can be followed by an analysis of used purchase items within a product line (Gelderman & van Weele 2002). Without an ERP system and its in-depth knowledge, a data collection is very difficult. At this stage, if no data is available, a 'qualified' estimation is an acceptable choice, too.

o Name (for each Product/Service) o Main customer objective o Gross profit o Turnover o % of gross profit o % of turnover o Cumulative % of gross profit / turnover o Lead time (and other) o Logistics provider o Main competitor o Competitor lead time (and other)

Table 5: Products and services strategy analysis metrics

After the collection information about products/services with related profits a high level 'as is' snapshot of the company's position should be available and future 'to be' business plans can be shaped. There are many ways to structure a business plan; within this thesis, taking the objective of the purchasing function as being to secure the supply of the company with goods and services; the following aspects should be considered within the corporate business strategy (Cox 1996, Monczka & Trent 1995, Morgan & Monczka 2003) of an manufacturing SME:

- Market sector(s), market value and current trends;
- Their own market position with market share, explanation of the main products, main customers, route to customers and strategic partners;

- Marketing and sales plan, explanation of future development plans (Figure 28);
- SWOT analysis: clarify strengths, weaknesses, opportunities, threats;
- Strategic action plan with cost and return on investment (ROI); especially considering new products & services, ICT or machinery.

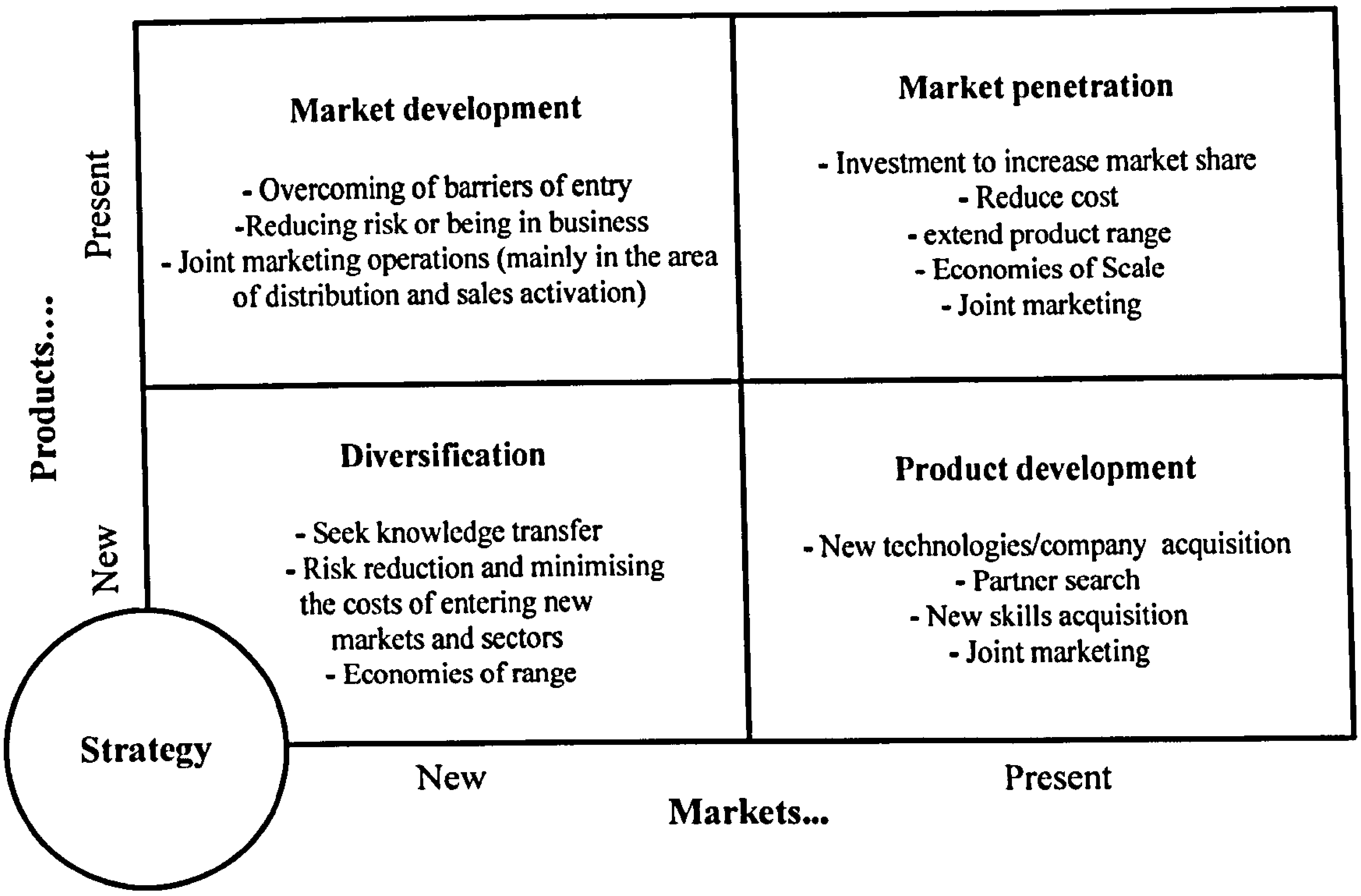


Figure 28: Market-Product-Matrix with business strategies

Even though all businesses are unique, it is useful to consider generic business life cycles (Table 6) when developing a purchasing strategy (Birou et al. 1997, Rozemeijer 2000). With increasing pressure on the business to innovate and reduce costs more measures are taken to utilise the potential of the purchasing function within the company. The competitive situation of a company greatly influences the procurement focus but not the drive towards collaborative electronic purchasing or other advanced ICT implementation (Huber et al. 2004). Aim is to develop purchasing from a supportive into a proactive role, from manufacturing support to integrated strategic sourcing considering the importance of qualified personnel to cope with evolving functions.

Stage	Management focus	Procurement focus
Design	Development, test, marketing; uncertainty assessment	Early supplier involvement, single sourcing, make-or-buy decision, decentralised purchasing
Introduction	product "debugging" and development; customisation, increasing variety	Supplier development, TQM, certifications, outsourcing
Growth	Mastering the production process, Six Sigma, Lean, increase responsiveness	Supplier lead-time reduction, JIT, performance evaluation monitoring, large volume suppliers, strategic alliances
Maturity	Cope with a decreasing growth rate and, compete by lowering production cost, customer service focus, concentrate on core activities, and adding new product models	Cost reduction, supply base reduction, blanket ordering, bundling service accounts, outsourcing, global sourcing
Decline	Increasing flexibility, responsiveness, product reengineering and substitution	Decentralised purchasing, part number reduction
Renewal	Develop new vision, focus on core competences	Outsourcing, co-operation with best-in-class suppliers

Table 6: Business life cycle stages with management and procurement strategies (Birou et al. 1997, Rozemeijer 2000)

Accordingly, the time frame for procurement should be different (Figure 29). For successful (procurement) management an explicit strategy is of vital importance (see Chapter 4.3).

Stage "Maturity" requires attention on short-term supplier and purchasing process, as the competition will be high. Stages "Growth" and "Decline" additionally require more intensive customer focus with subsequent timely supplier integration. "Design" and "Renewal" stages require assessing suppliers and partners in even greater detail. However, the purpose of the purchasing function within a company is still to assure the required supply. This includes the administration of current demands and the involvement in the planning of future demands.

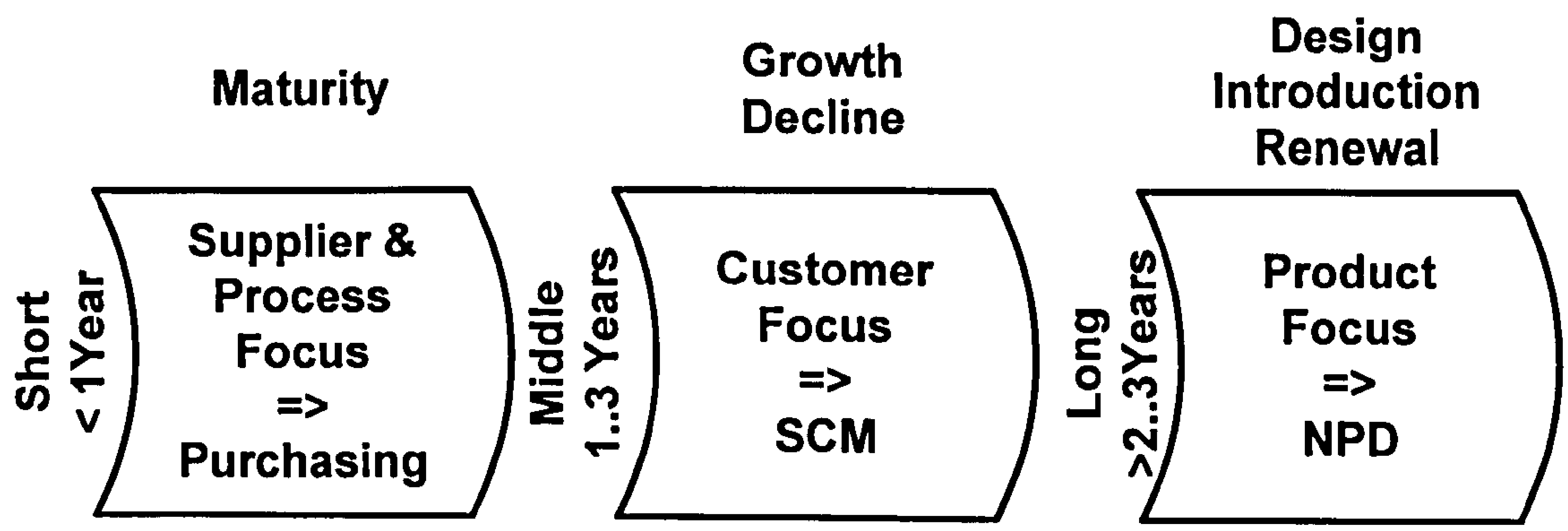


Figure 29: Procurement time horizon within business strategy

Many companies do not offer products that differentiate them from their competitors as they are contractors in the 2nd or 3rd supply chain tier, in particular small SMEs. They have to differentiate themselves considering, for example, SCOR level one metrics such as Supply Chain Responsiveness as a basis (Table 1) and focus on the optimisation of level two or three processes. Therefore the analysis of customers (Table 4) and products (Table 5) is very important.

When considering the above within the corporative strategy, according to a research study conducted by CAPS (Centre for Advanced Purchasing Studies) procurement has significant influence on (Monczka & Trent 1995):

- Competitive capability, performance improvement requirements, and purchasing concerns;
- Purchasing/sourcing strategy integration, decision making, and responsibilities;

- Purchasing/sourcing strategy emphasis areas;
- Supplier importance and performance capability improvement;
- Worldwide sourcing;
- Purchasing measurement and evaluation;
- Purchasing systems.

It is, however, not the intention of this research to provide an in-depth framework on how to develop a corporate strategy. The focus is on the development of an electronic procurement SME consortium. Individual business strategies of participating companies have to be adopted towards collaboration in purchasing. This chapter provides generic ideas relating procurement to corporate strategy. Analysis and implementation on individual basis (which does include up to 30 DEF companies) have to be part of future research.

4.3 RECOGNITION OF CORPORATE MANAGEMENT CHALLENGES

In order to understand the structure, tasks and tactical deployment of the procurement function within a company the major current managerial trends have to be considered. From a purchasing perspective, it is the role of the management to coordinate fulfilment of the link between customers and suppliers (Figure 25), to consider the strategy (Chapter 4.2) when overseeing purchasing items and suppliers (Chapter 4.5).

Major tasks are to influence the expenditure profile and the workflow process, which obviously assumes the availability of captured information. Three main movements of today's economy also need to be addressed by a appropriate corporate management strategy (Eschenbaecher & Zwegers 2002): economic globalisation, increased customisation and core competence focus. In addition, Table 7 summarises the transient trends of the last decades (Bititci et al. 2003, DTI 1998).

In the 1980s, the focus was on the perfection of the highly functional working enterprise with, what would today be seen as a departmental 'functional silo' structure. One major drawback was the low organisational flexibility, the ability to deal with uncertainty (Gerwin 1987). In the next decade, enterprises became 'lean' with a flat organisational structure focussing on flexibility and supply chain improvements. With the year 2000 collaborative and agile companies are focusing on continuous adoption of products, processes, people and striving for collaboration with the benchmark champions acting as suppliers (Bititci et al. 2003).

Trends in Table 7 were state of the art at the time. Industry standards are changing very slowly, and companies are very cautious in changing business habits until a maturity stage of new technology is reached. Theses transient development stages of the past have to be considered when analysing the own company within this purchasing framework; not all areas within the company progress equally. For this reason, a functional structure with departments working autonomously of each other can still be found in many SMEs, which puts procurement in a position in the value chain that constitutes its clerical and administrative character. Common ERP systems provide insight for the user into only a few 'screen forms' directly related to its work contribution and authorisation. For a certain percentage of procurement employees, but also depending on the business context of the company, this will not change in the future.

Management needs to identify quantifiable objectives towards the more qualitative and long term strategic aims to steer and direct a company (Bolstroff & Rosenbaum 2003, Harland et al. 1999, Knudson 2002, Nollet et al. 2005). In this thesis only the purchasing function is considered in detail;

	1980s	1990s	2000s
Operating philosophy	• Product/process oriented • Just-in-case • UK / Europe	• Customer service oriented • Just-in-time • Waste minimized • Business processes	• Market focused • Customer value • Mass customization • Collaborative • Responsive • Easy to adapt and change
Organisation	• Hierarchical • Functional • High % of indirect	• Flat • Matrix • Minimum indirect	• Flexible
Processes	• Manual • Stand-alone • Long set-ups	• Manual / automated • Integrated • Short set-ups • Flexible	• Very flexible • Innovation • Environmental • Sustainable • Short life-cycle
People	• Individuals • Specialists • Self-oriented	• Teamwork • Multidiscipline • Company oriented	• Strategic leadership • Flexible • Self managed • Extended-process oriented • Social responsibility
Product	• Designed separately from process	• Design for manufacture • Simultaneous engineering • CAD/CAM	• Innovation • Short life-cycles • Global
Quality	• Inspected in • Assured	• Designed in • Total • SPC	• Corporate excellence • Habitual • Granted
Facilities	• Use existing space • Functional	• Minimum space • Cellular	• Alliances • Global • Mobility • Flexible
Finance	• Standard costing • Direct labour allocation	• Actual costs • Activity based	• Working capital • Integrated performance management
Information	• Mainframe (Slow) • Batch processing	• Distributed (fast) • Networked • On-line	• Real-time (very fast) • Web based/facilitated • Work flow management • Integrated communication
Materials	• Large inventories • Large batches • Adversarial vendor relationships	• Minimum inventories • Lot size = 1 • Partnerships • Supply chains	• Max. throughput • Flexible value chain • Extended partnerships
Overall posture	***Just-in-case Enterprise***	***Lean Enterprise***	***Collaborative & Agile Enterprise***

Table 7: Trends in manufacturing and business of the past decades (Bititci et al. 2003, DTI 1998)

On the other hand, an increased outsourcing share and the management of involved suppliers require a significant input of different hierarchical levels such as managing director, financial manager, production manager. The functional level – close to the problem area – has a low decision making authority, whereas the management level lacks insight. A systematic structure to clarify responsibilities should be enclosed in a procurement strategy. However, what is the aim? According to the procurement/purchasing definition, it can be summarised as: to assure the supply of required goods while minimising risk.

4.3.1 Macro environment

Macro environment factors influence the environment of a company, but a company cannot influence them, for example, price of raw materials or tax rates. Large or multinational organisations own a critical mass to become globally active whereas small companies have to collaborate:

- Economic globalisation is the process by which businesses or other organisations start operating on a global scale (COED 2005) - especially the increased level of trade and movements of capital - brought on by lower costs of transportation and communication (Gebauer & Segev 2001). (Note: There are different aspects of globalisation, for instance cultural globalisation is bringing about convergence and 'homogenisation' in world culture. This is not considered in this thesis.)

- Outsourcing: The term 'core competence' has a growing importance (Do et al. 2006, Heshmati 2003), logically followed by an increased share of outsourced processes and services. It can be also considered as decreased production depth linked with increased bought in material and parts volume. A continuation of the production of one's own products is suggested where a company has superior or at least advantageous competency as a result form a benchmark study (see Chapter 2.2). Outsourcing requires that technical knowledge previously held solely within, for example, R&D and production departments, is shifted to departments or teams responsible for procurement. This ensures that the correct specifications are provided to the new suppliers. Complex technical questions have to be decided, suppliers have to be managed and workflow processes or project plans have to be integrated. In the short term, outsourcing will provide access to high-class competitive products, services and partners, but in the long run people-embodied skills and knowledge for core competences will be imperative (Giunipero & Handfield 2004).

- Customisation: One aim of SCM is an optimal response to customer demand pattern changes through their own company involving suppliers. Sophisticated customisation places flexibility on the customer side by increasing the pressure on procurement to shorten the lead and response time with suppliers.

- New ICT: The first expectation of new ICT is to increase the efficiency but also to obtain competitive advantages by deploying ICT to support the strategic purchasing (Carr & Smeltzer 1999) management function. Another aspect of new ICT is the opportunity of BPR (Business Process Redesign). Based on "electronic" workflows there is the chance to combine several multi-department process steps and empower employees to do tasks only once, namely by the person with the demand. This influence of ICT might be seen in a way of encouraging flat enterprise hierarchies towards process oriented teams which is a direct threat to the middle management (Chesher & Kaura 1998). SCM related tasks are carried out by middle or top management (White & Hanmer-Lloyd 1999).

4.3.2 Micro environment

The micro environment consists of competitors, customers and suppliers and influences SMEs directly. In this context the term 'micro' describes the relationships between firms and the driving forces that control the relationship.

- Competitor: Globalisation heightens competition, hence procurement strategies should include competitor benchmarking (see 2.2 and 4.2).

- Customer: Companies in general and SMEs in particular are becoming increasingly dependent on buyer markets where many sellers canvass potential buyers. This leaves customers in a strong position leading to short product cycles, customised products and increasing after sales support. Implementation for purchasing is that with decreasing unit quantity the complexity is increasing. Customer (and product / service) analysis is discussed in chapter 4.2.

- Supplier: The most important change with regard to supplier relations in recent years is an increasing price transparency brought by the Internet, which is strengthening the position of the buyer. Together with reliability and quality, price is the critical factor for supplier assessment. Quality can be defined as the total of features and characteristics of a product or service that affect its ability to satisfy a given need (ANSI 2005, Crosby 1979). The importance of a supplier is strongly related to the purchased product, which will be discussed in chapter 4.5.1. The management of suppliers also relates to the working procedures of procurement within an organisation, which will be discussed in chapter 4.5.4.

4.3.3 Important considerations for purchasing management

In the field of procurement, many times the managerial input at different hierarchical levels relates to financial transaction limits, varying for each organisation. Corporate management should consider procurement within the following areas:

- **Business context:** is related to respond to outside conditions (micro 4.3.1 and macro 4.3.2 environment) and should give information about the approach towards suppliers for item categories, for example, how many suppliers (see 4.5.4) are there for strategic supply? On the other side the customers approach towards the company's products will influence the procurement strategy, for example, make-to-stock or make-to-order.
- **Organisational structure** (see 4.5.4): will consider the dependency of the purchasing department to other departments or the degree of involvement in new product development (van Weele 2005).
- **Item classification** (see 4.5.1): should be conducted into leverage, strategic, bottleneck and routine and derive a plan how to handle them.

When controlling and directing a business managerial considerations are related to assigning long-, medium- and short-term activities (Figure 30):

Short-term focus is on the realisation of the supply of required goods and services. This is many times a repetitive and administrative task. Considerations from a managerial perspective relate to resources and time. Halt points and transaction limits need to be decided. The development of a collaborative consortium is described in Chapter Seven; it can reduce process time and develop competence centres within the group.

As intended within this project, procurement activities may be increasingly outsourced but technical and financial advice will be necessary to remain in-house. Also inherent to trends such as globalisation, increasingly cross-functional or geographically scattered teams will be formed.

To assure supply of direct materials and services management can develop a commodity strategy (see 4.5.1) and implement control mechanisms. This includes assessing the commodity status for items with high profit impact and competitive advantage (commodity status report) and to review the strategy for supply risk bottleneck and low value items.

Permanent monitoring of performance is necessary, as the supply is critical but also to agree on continuous improvement measures. Appropriate service level agreements, pricing structures and developments to acquire a deep understanding how the supplier's market is working over time.

Medium-term tasks to maximise the possible impact of the purchasing function relate to optimise current supplies. This includes the systematic monitoring of supplies, the classification of items and striving towards cross-departmental involvement; an increasing managerial involvement is necessary.

A purchasing management systematisation process includes a cost reduction plan for commodities and the assessment of the cost reduction status for commodity families and special items (commodity status report). Management report statistics from ERP system can be used; results should be benchmarked with purchasing data of competitors (AMR Research 2004, Hoover 2004, PMG 2005).

This includes aims such as reducing inventory costs by increased co-operation with suppliers or defining on-time delivery requirements incorporated in a supplier status report (see 4.5.4). Here the purchasing management defines and agrees quality metrics and standards such as following ISO 9000 or Six Sigma concepts with suppliers to minimise in-house inspections; selection criteria for suppliers, evaluation processes, monitoring, and development plans on tactical level are decided.

A systematisation aims many times at a supply base reduction with intensified partnering, preferably involving the "best-in-class" suppliers for strategic items (supplier status report), to invest with a fewer suppliers into tight electronic integrated systems. Therefore a supplier requirement plan can be developed with focus on turn-key solutions or component management. The supplier status report outlines a base for an action plan for non-performing suppliers (supplier action plan); the definition of a problem solving approach is necessary and if unsuccessful a risk assessment on supplier replacement.

Finally medium-term managerial task in purchasing relate to the systematic introduction of purchasing information, automation and monitoring ICT.

The **long-term** part of the purchasing function embeds into the corporate strategy by aligning customer requirements with supplies. Considerations necessitate deep customer requirement knowledge and in-depth supply market information. A framework such as SCOR (Supply Chain Operations Reference model) in conjunction with metrics can provide ideas for SCM. An assessment and a decision on what metric to benchmark (SCOR framework) are necessary. Within many SMEs, this requires the management, represented many times by company owners, to consider purchasing and supply chain knowledge. This includes identifying the core competences and main income streams, which can lead to outsourcing or in-sourcing decisions.

Important long-term focus of the purchasing management is the early involvement in new product, technology and process development. This includes fostering cross-functional teams internally (purchasing maturity see 4.4) and supplier involvement externally. Suppliers that are critical for the business are still changeable. This is not true for core suppliers, for example, when delivering for a unique material or essential parts of their own product.

Based on the analysis of the micro and macro environment, the following considerations for management of procurement activities emerged (Figure 30): Management of short-term activities relates to establish controlling mechanisms for the ordering process; short-term staff activities are administrative. Within the medium-term time frame monitoring activities of purchasing staff enable management to systematise supplies. Long-term staff activities aim to communicate effectively with other departments internally and suppliers externally. Managerial long-term purchasing tasks relate to the supply chain; namely, the optimisation of linking customer demands with supplies.

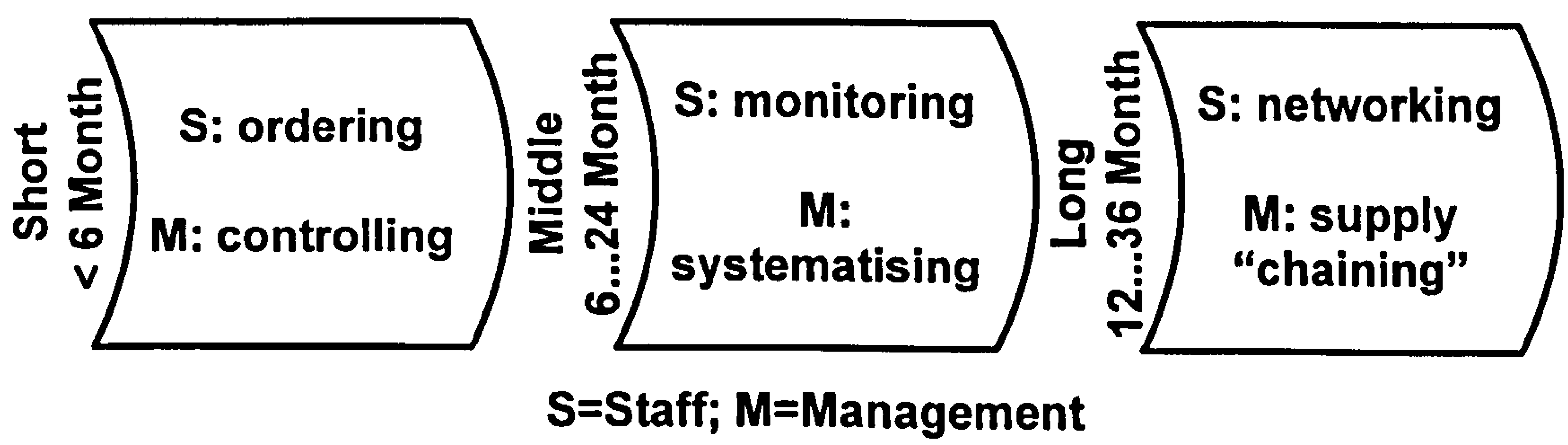


Figure 30: Activity time horizon of purchasing management and staff

4.4 PURCHASING MATURITY

The traditional purpose of the purchasing function within SMEs is to assure the supply of the organisation with the required goods. Supply chain management's purpose encompasses, amongst other issues, the fast translation of customer orders and requirements into supplier communication.

Purchasing maturity can be defined as the level or measure of professionalism in purchasing (Rozemeijer 2000); it includes the perceived value of the purchasing function itself in an organisation and the degree of involvement of purchasing into other corporate functions. Purchasing maturity was viewed over the last decades from different angles and models and in essence, an incremental development of the purchasing function is recognisable. Purchasing maturity as used is related to the stages of strategic management (Cavinato 1999). Emphasis is not on characterising the "level-position" of a company but rather on flexible characteristics that should be considered in all stages giving an action recommendation. A self-assessment of the purchasing maturity should be used to steer the development of the purchasing function within the own organisation.

The way companies approach suppliers and set up the purchasing function internally should consider the following factors (Rozemeijer 2000):

- Purchasing organisation status (see 4.5.2 and 4.5.3): There is a development from clerical/servant functionality towards supply chain management (van Weele 2005). In addition, there is a relationship to the particular industry of a company. In the case of purchasing working at a transaction oriented stage, an exploitation of purchasing synergies on corporate or even inter-organisational level will be very difficult.

- Supplier management and relationships (see 4.5.4): Depending on the particular purchasing item and the market, supplier relationships tend to develop from purely competitive "arms length" to partnerships. Purchasing is managing all inbound materials and services. Partnership formation is not a one way street, a supplier might expect, for example, to gain an increased volume, order security and less competition (Ramsay 1996).

- Knowledge and innovation management: With the increasing complexity of the purchasing process due to trends towards outsourcing (make or buy), globalisation, lower product life cycles and continuing price reduction pressure there is the requirement for the purchasing department to manage cross-functional (internal and external) teams, responsibilities and workflows (Cavinato 1999).

A high maturity purchasing process is characterised by increased spending with outside parties (Rozemeijer 2000). This can be measured by analysing the structure of recent expenditures, which should be related to non-core competences. This metric is only expression of the importance or "maturity" of the purchasing function itself. It was found that a high purchasing maturity is also characterised by working in cross-functional teams involving line management (Handfield & Straight 2004). The perceived relative importance of the purchasing function within an organisation will be indicated by the way of reporting to the senior management (Gelderman & van Weele 2005). Figure 31 summarises the orientations of the purchasing function focussing pure functional and cross-functional involving purchasing "outsiders" as well.

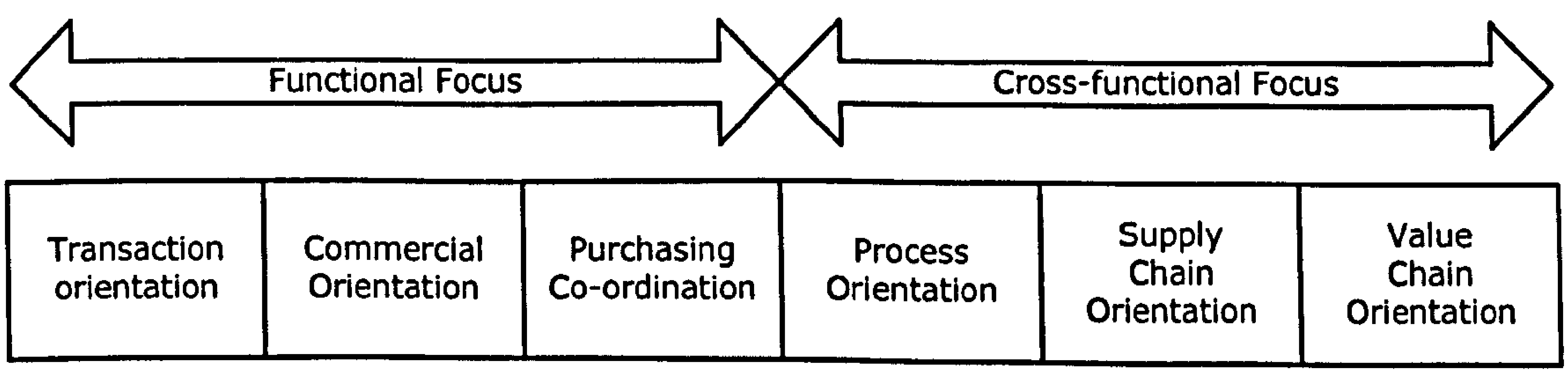


Figure 31: Development model with internal and external purchasing function integration (Rozemeijer 2000)

4.5 A SYSTEMATIC APPROACH TOWARDS PURCHASING

As stated a few times before, SCM should link customer requirements with purchases. The following part discusses considerations of actual purchase items and process. The second part of this section elaborates high-level metrics and suppliers management issues.

4.5.1 Purchasing items

Equally important to the "sources" of income are "sinks" of expenditure, namely the purchased items and services. Hence, core ideas of supply chain management are related to both (sinks & sources) and streamline internal processes. The challenge for the procurement function of individual companies is to manage tradeoffs between transportation, inventory control, warehousing, and customer service. Important fields to start an item classification are listed below (Table 8), which is obviously very closely related to a supplier monitoring/rating as well. The importance of purchased items depends on (Caniels & Gelderman 2005, Kraljic 1983):

- Internal importance of the item: (a) value added by product line, (b) percentage of raw materials in final products, (c) impact on profit and other (Figure 32);
- External complexity of supply markets like monopoly/oligopoly, technology change, ability to change materials, market entry barriers and logistics cost.

o Name o Item number o Item price o Item lead time o Severity rating on profit o Severity rating on supply risk o Supplier (current, potential) o Order number(s)	o Delivery (timeliness and correctness) o Quality (OK or damaged) o Documentation (OK or incomplete) o Rating / Notes (monitoring current supply) o Ranking

Table 8: Metrics for continuous monitoring of supplied items

Depending on the purpose there are many ways to classify purchasing items, most of them following Kraljic's purchasing portfolio matrix (Kraljic 1983) aiming at minimising supply vulnerability and increasing potential buying power. A categorisation of purchased items into the four groups should be conducted:

- partnerships for strategic items (Dubois & Pedersen 2002);
- assure supply for bottleneck products;
- exploit power for leverage products;
- ensure efficient processing for non-critical products.

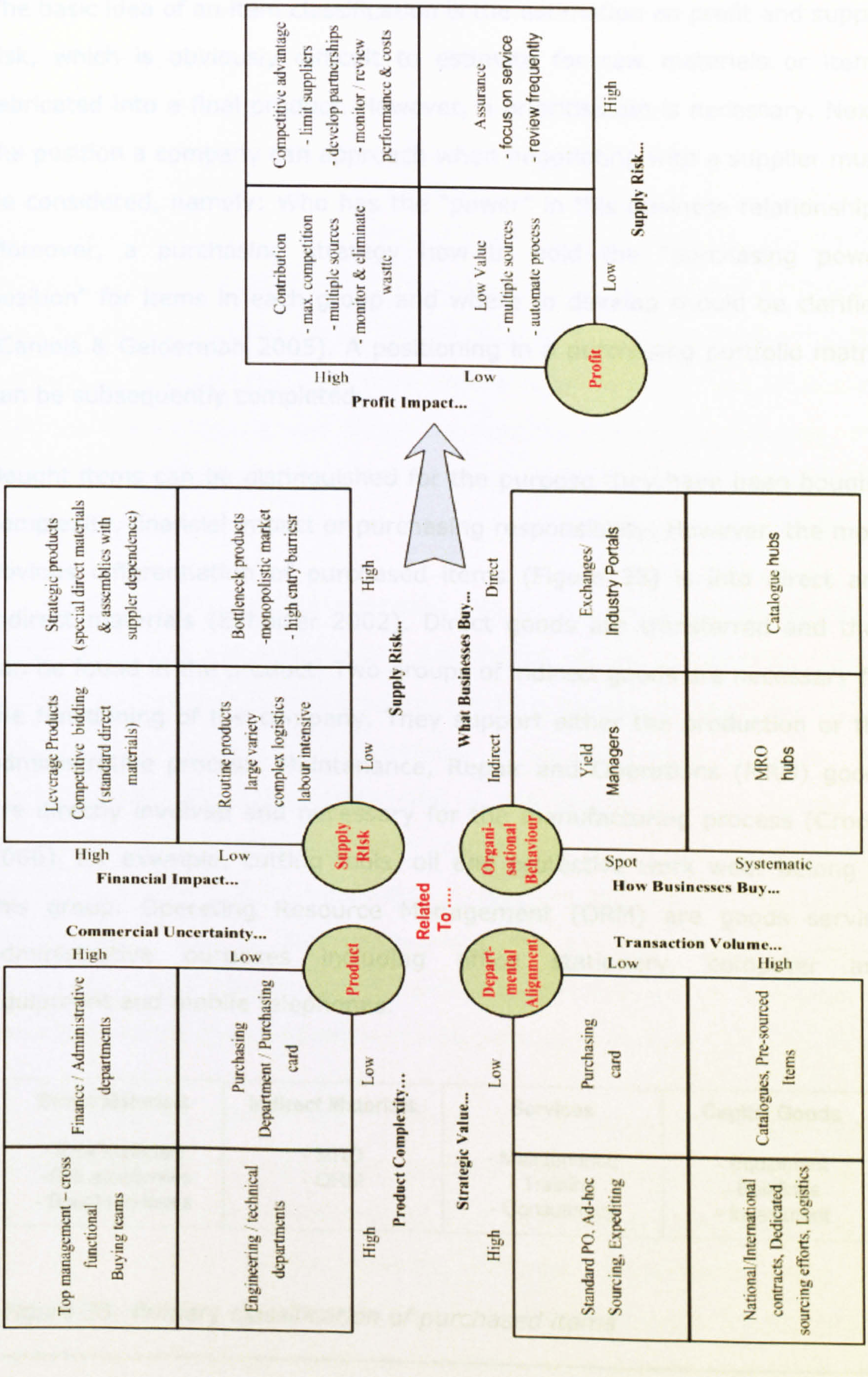


Figure 32: Common purposes of purchased item differentiation (Gelderman & van Weele 2005, Kraljic 1983)

The basic idea of an item classification is the estimation on profit and supply risk, which is obviously difficult to estimate for raw materials or items fabricated into a final product. However, a prioritisation is necessary. Next, the position a company can approach when negotiating with a supplier must be considered, namely: Who has the "power" in this business relationship? Moreover, a purchasing strategy how to hold the "purchasing power position" for items in each group and where to develop should be clarified (Caniels & Gelderman 2005). A positioning in a purchasing portfolio matrix can be subsequently completed.

Bought items can be distinguished for the purpose they have been bought, complexity, financial impact or purchasing responsibility. However, the most obvious differentiation of purchased items (Figure 33) is into direct and indirect materials (Eyholzer 2002). Direct goods are transferred and they can be found in the product. Two groups of indirect goods are necessary for the functioning of the company. They support either the production or the administrative process. Maintenance, Repair and Operations (MRO) goods are directly involved and necessary for the manufacturing process (Croom 2000), for example, cutting tools, oil and protective work wear belong to this group. Operating Resource Management (ORM) are goods serving administrative purposes including office stationery, computer and equipment and mobile telephones.

Direct Materials	Indirect Materials	Services	Capital Goods
- Raw Materials -Sub assebmlies - Bought-in-Items	- MRO - ORM	- Maintenance - Training - Consultancy	- Equipment - Buildings - Investment

Figure 33: Primary classification of purchased items

Further differentiation of purchased items depends on the particular purpose of the classification activity. The following approaches of categorising purchasing items were identified as important (Figure 32):

- Product related (van Weele 2005): The purchase of simple products with a low value can remain within the clerical section of the purchasing function. Complex products that require technical competence during the procurement process require the involvement of appropriate staff within the technical department, whereas very expensive products call for sanctioning from the finance department within the financial plan of the company. The most complex and expensive items have to pass the top management confirmation process.

- Risk related: Another viewpoint can be the special consideration of supply risk and the appropriate treatments of the categorised items. Routine and labour intensive products will be purchased through the clerical function of the purchasing department or by the person triggering the demand itself. Expensive items with a low supply risk are subject to competitive bidding on the supplier market. To supply the company with bottleneck products, tight and long-term relations with suppliers seem to be the solution. This is also appropriate for strategic (and expensive) purchases, which require furthermore the development of "competitive" knowledge within the company in the target supply market.

- Purchasing department structure related (Allen 2003): Specialists from different departments in the company (design, production, purchasing) will influence the purchasing process from their perspective. Depending on the value and transaction volume, different departments enact the purchasing function. Strategic items are purchased through the purchasing department often overseen by senior management, whereas the requisitioner purchases low value items.

- Organisational behaviour related (Kaplan & Sawhney 2000): Internet technology emerging in the last decade has certainly changed the buying behaviour and strategy. Materials can be purchased following an on demand vs. a systematic long-term strategy for direct and indirect materials. The challenge is to adapt electronic commerce capability per each individual organisation. Exchanges or industry portals provide a wide range but less specialisation compared with catalogue hubs of individual suppliers. Other decisions how an organisation acts in the market can be measured by duration of supplier relationships.

Figure 32 summarises approaches to classify purchased items (Kamann 1999). All have their justification and should be measured appropriately but considering scare (financial) resources of most SMEs the impact on profit in relation to potential supply risk should dominate the classification. Low value / low profit impact items are purchased through web sites or on-site product catalogues. Collaboration with other businesses is an attractive scenario, as it is for "contributing" items (to the profit) such as many direct standard materials. High supply risk items and supply that secures a competitive advantage are special to individual businesses. Managerial tasks are the item classification and to assign control and administration responsibilities.

As mentioned before, a very important way of classifying bought items is given by the relation of quantity and value, also called ABC analysis. The result is an overview of the number of articles against their cost (Figure 34). It is a common feature provided by many ERP systems providing an item differentiation against the price (Gelderman & van Weele 2005). The actual percentage value will vary, but in general there are a few items (A-articles: 5-10%) which bear the majority of the purchase expenditure (50-80%). There is a group of medium value (B-articles: 15-40%) constituting 15-40% of the total number of articles. Finally, the majority of purchased items (C-articles: 50-80%) will just contribute 5-15% towards the total purchasing budget.

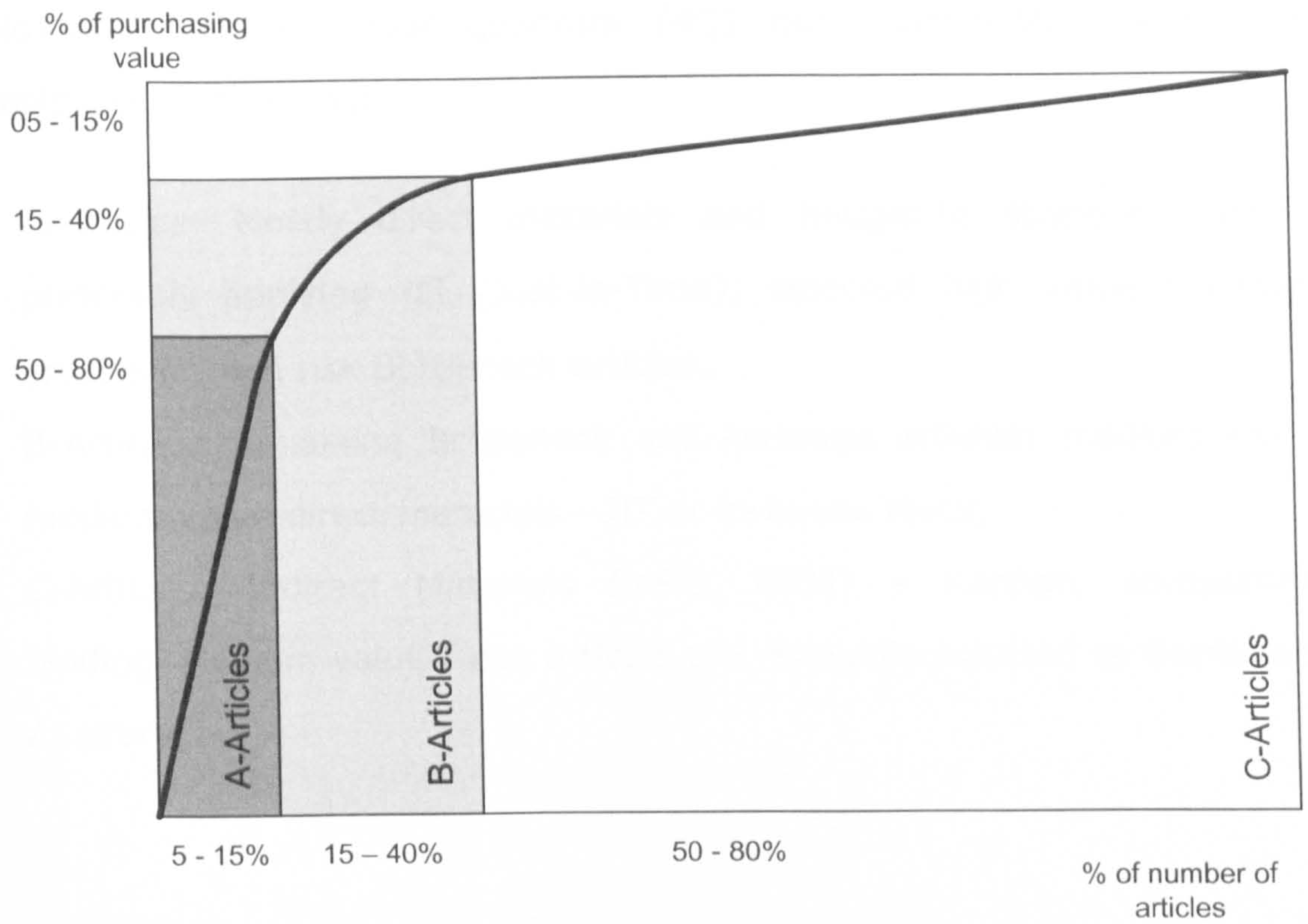


Figure 34: ABC-Analysis of purchased articles

Many times, these articles have to be maintained within an ERP system and purchase transactions have to be processed. This is the reason why it is important to automate the purchasing process for C-articles as much as possible to reduce clerical work in the purchasing department by conducting all possible work steps of procurement as closed to the actual requisitioner. Purchasing of C-articles takes a considerable amount of time, which should be related with A- and B-articles. The filtering of "bottleneck" or strategic items by classifying them manually as A or B-articles is very important for the ABC-Analysis. All the considerations above, for example, transaction volume, buying behaviour, uncertainties of Figure 32 should help in the classification process.

The following approach was developed to merge the 4-Quadrant "Strategic - Leverage - Bottleneck - Routine" classification (Figure 32) with the ABC analysis (Figure 34). When conducting an ABC-Analysis additionally the following points the four quadrant (4Q) item classification should be considered (Figure 35):

- A-Articles: Mostly direct materials and bought-in strategic parts - preferably applying JIT (Just-in-Time); selected high value Leverage articles or high risk Bottleneck articles.
- B-Articles: remaining Bottleneck and leverage articles; medium risk / medium value direct materials - JIT or in-house stock;
- C-Articles: Indirect Materials (MRO, ORM) – Kanban, competitive bidding. Medium value / risk articles are manually selected as Bottleneck / Leverage

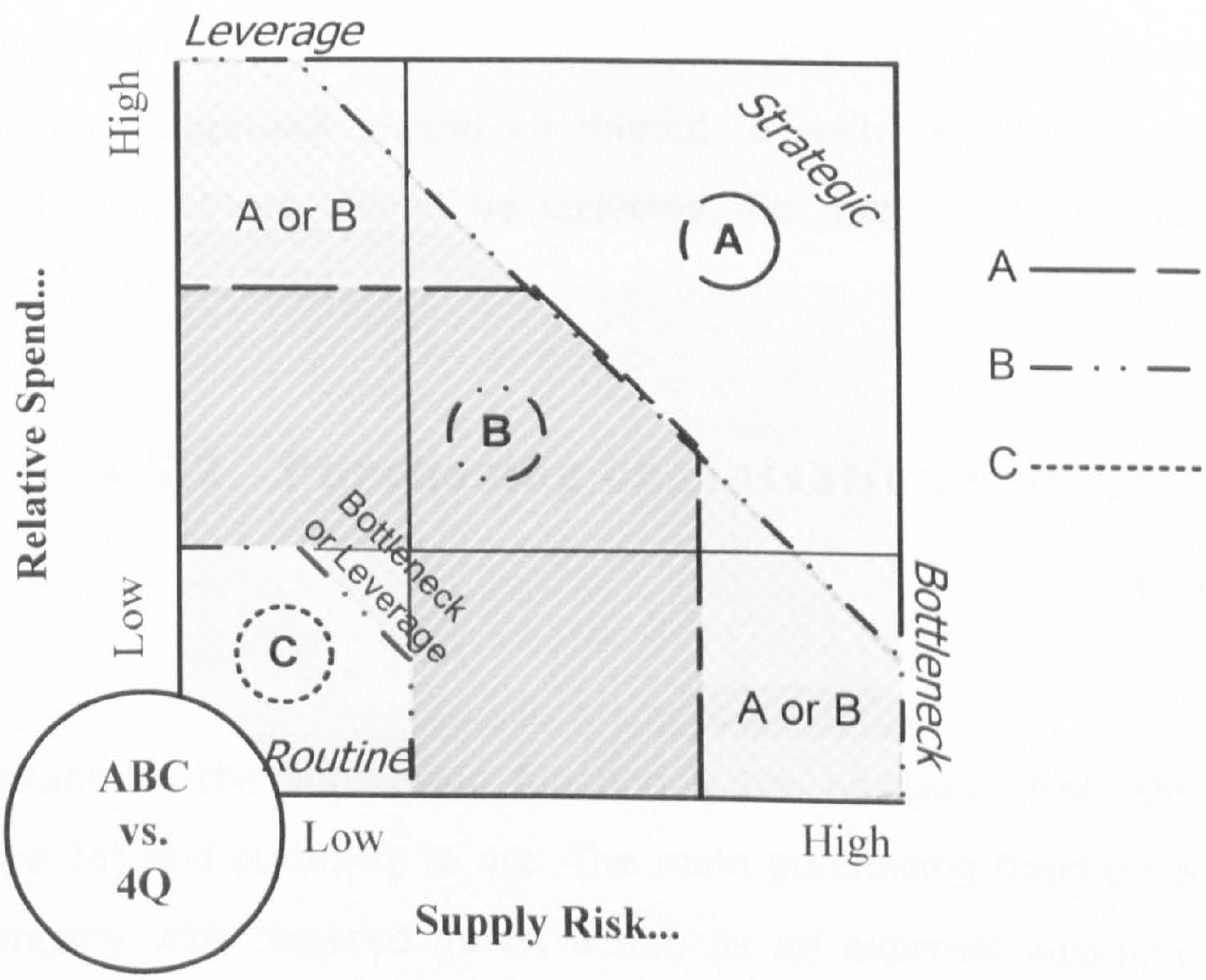


Figure 35: Combination of ABC and 4-Quadrant item classification

Hatching in Figure 35:

- No hatching:
  Top right: A-articles, strategic
  Bottom left: C-articles, routine
- Single hatching:
  Middle: B-articles, medium risk and value
- Double hatching:
  Manual selection of B-articles from medium risk and value C-articles
  Manual selection of A-articles from high risk and value B-articles

For the purpose of internally measuring of purchasing performance, it is necessary to divide purchased items into groups with defined metrics. A good approach might be to use the annual spend turnover per item and their potential impact on the company's profit. These metrics need to be reviewed periodically. In addition, a systematic cost reduction or at least cost control approach should be related to each item family. Benchmark data of competitors should be collected, for instance from sites such as Hovers (Hoovers 2004).

4.5.2 Purchasing organisational structure and workflow

Important for the purchasing function is the position within the company (Figure 36) and authority to act. The main purchasing function is to supply a company with required goods acting as an external incoming gateway. Hence, the relation with the production department is firm. The purchasing process itself - which can be assessed using purchasing maturity metrics (see 4.4) - should be considered within the corporate strategy (Chen et al. 2004) or at least on departmental level.

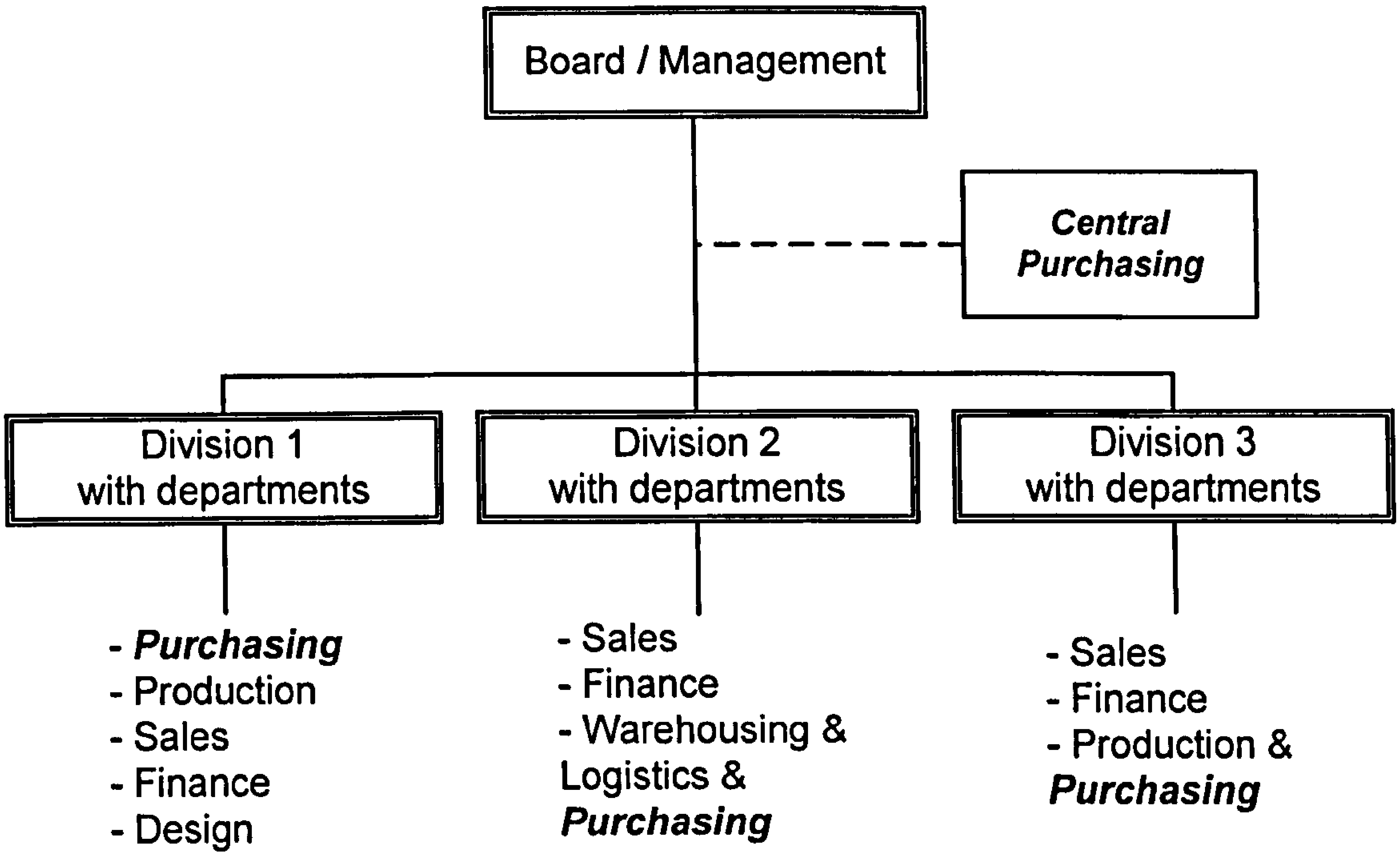


Figure 36: Scenarios for purchasing structure within an organisation

There are many ways to organise the organisational structure (Figure 36); purchasing can report to the finance department as it always includes financial transactions, which are critical in particular for SMEs, or to the logistics department due to a physical move of goods. As purchasing is essential part of supply chain management the purchasing department may also report to general management.

Depending on the importance of the purchased goods concerning the organisational structure, it can be differentiated into:

- Strategic: purchase decisions influence the long-term market position of a company over years. The development of process guidelines for purchasing is also strategic, for example, multi or single sourcing. Decisions about long-term contracts with direct materials suppliers or bought-in strategic parts and outsourcing of current activities are strategic lead by top management as 'invisible' purchasing practitioner (Knight & Zheng 2003).

- Tactical: control of the purchasing process will affect the products, production, processes and current suppliers within a medium time frame over several months. This is including supplier agreements such as the purchase work wear over an annual period for a fixed price. Item standardisation, supplier assessment/monitoring and supply base reduction programmes are tactical. Standardisation is the process of agreeing and adopting generic specifications and controlling variety (Lonergan 2003).

- Operational: decisions will involve the actual ordering and expediting process. Data gathering and pre-processing to support tactical and strategic decisions is an operational task, trouble-shooting and fire fighting the systems insufficiencies.

There is a lot of criticism about a supposed lower role of purchasing within an organisation. Firstly, purchasing decisions involve strategic (for example, outsourcing) and financial critical decisions (for example, raw material purchase cash flow) where an appropriate managerial level needs to be involved. Secondly, purchasing staff will not have every time the required knowledge to accomplish technical decisions; this will involve engineers from the technical department itself. Therefore, increasing the influential power of the purchasing department is not a correct approach to but rather developing the organisational decision infrastructure in a way that supports cross-functional purchasing.

Purchasing can provide strategically important support when accessing suppliers unknown to competitors or preventing competitors working with certain suppliers, for example through special contracts or shares of the supplier company. Normally, this advantage cannot be maintained over a long period. Most available ERP systems support the purchasing function but almost every company is struggling with maintaining up-to-date C-Articles databases. The communication with suppliers (or customers) ERP systems is usually disconnected (Figure 25), which means that a purchase order will not automatically become a sales order. The purchasing workflow itself is not very complicated and the subject of frequent research (Bogaschewsky 1999, Carter et al. 2000, Carter 1998, Eyholzer 2002, Schinzer 2000, van Weele 2005):

- Purchase requisition with specification;
- Market research including quotation/bidding process;
- Bid comparison and authorisation process;
- Contract agreement and ordering;
- Expediting, Monitoring, Evaluation.

These steps will differ when considering different purchasing classes:

- Straight re-buy: occurs when, for example, buying office supplies or raw materials;
- Modified re-buy: is a situation when, for example, the purchase of office furniture or computer hardware is requested;
- New purchasing task: is emerging when buying production equipment or buildings.

The following field structure is a good starting point for purchasing process assessment (Table 9):

- Rank
- Process Name
- Process time
- Frequency and horizon for planning
- Number of people involved
- Process reliability (right first time)

- Number of process steps
- Consequences of failure

Table 9: Metrics for continuous purchasing process assessment

Another important point in the procurement workflow is the order penetration point (OPP). It is the point in the value chain of a company when general forecasting and planning activities become customer specific (Christopher 2000, Mahler & Singh 2002). Depending on the chosen manufacturing strategy Making-To-Stock (MTS), Assemble-To-Stock (ATS), Make-To-Order (MTO), Engineer-To-Order (ETO) and Just-in-Time, Lean, Kanban the purchasing workflow will have to be adopted.

A crucial factor concerning collaborative purchasing is its relation to production. Obviously, there is a greater degree of freedom when non-critical items are bought and the commitment to keep up the production precedes potential benefits. From a viewpoint of an intermediary, this kind of "spot" collaborative buying limits the benefits to normal volume discounts. Further benefits are based on economies of scale where suppliers can schedule their production. Due to the involvement of several parties, collaborative purchasing exposes its main disadvantage: for both buyers and sellers uncertainties and delays are involved until the final price is determined. This includes members of the collaboration leaving for various reasons before the negotiation is finalised.

A more efficient electronic system reduces clerical and administrative work and further increases the transparency of the workflow processes which leads in turn to more functional rather than purely process related work. Hence, procurement staff of SMEs will work more and more in cross-functional teams as well (Eyholzer 2002). Another side effect of cross-functional teams involving procurement is a shift of accomplishment towards the demand origin, which will reduce duplication of work and misunderstandings.

4.5.3 Purchasing culture

The term culture refers to the customs, ideas and social behaviour of a particular group. In a business context, the term culture refers to 'the way things are done in our company' (Stannack 2003). Purchasing culture can be understood as the way an organisation behaves with regard to the purchasing function both internally and externally.

The change and development of a purchasing culture is a long-term process strong related to individuals and organisations. The following points should be considered besides the operational purchasing towards appropriate consistency of decisions:

- local vs. global sourcing;
- single vs. multi sourcing;
- long-term vs. competitive bidding;
- order frequency vs. stock level;
- cost reduction plan with cross functional teams;
- supplier involvement and understanding of suppliers objectives;
- management overview statistics to assure involvement and interest.

When seeking collaboration, the 'way things are done' within each individual company has to consider other organisations. There will be additional time necessary for internal discussion on technical parameters. Additionally, collaboration may require process, workflow or organisational changes too. This is discussed in section 4.2, however, individual assessment or actual purchasing process change within consortium member companies are subject of further research.

4.5.4 Supplier management

Finally, suppliers usually do not respond enthusiastically towards purchasing consortia (Schotanus 2007). However, a top business priority of a supplier is the generation of income, too. It is obvious that suppliers of indirect goods and materials are viewed differently from strategic suppliers. Important factor for the management of suppliers is the degree of cooperation (Eyholzer 2002), which depends on (Figure 37):

- Volume, order frequency;
- Strategic importance to buyer / ability to change supplier / number of competitors;
- Geographical connection: global (bulk/standard products, few deliveries) vs. local (changing specification, flexibility (Jeeva 2004), delivery timeliness, intensive communication);
- Missing knowledge to "e-enable" own processes.

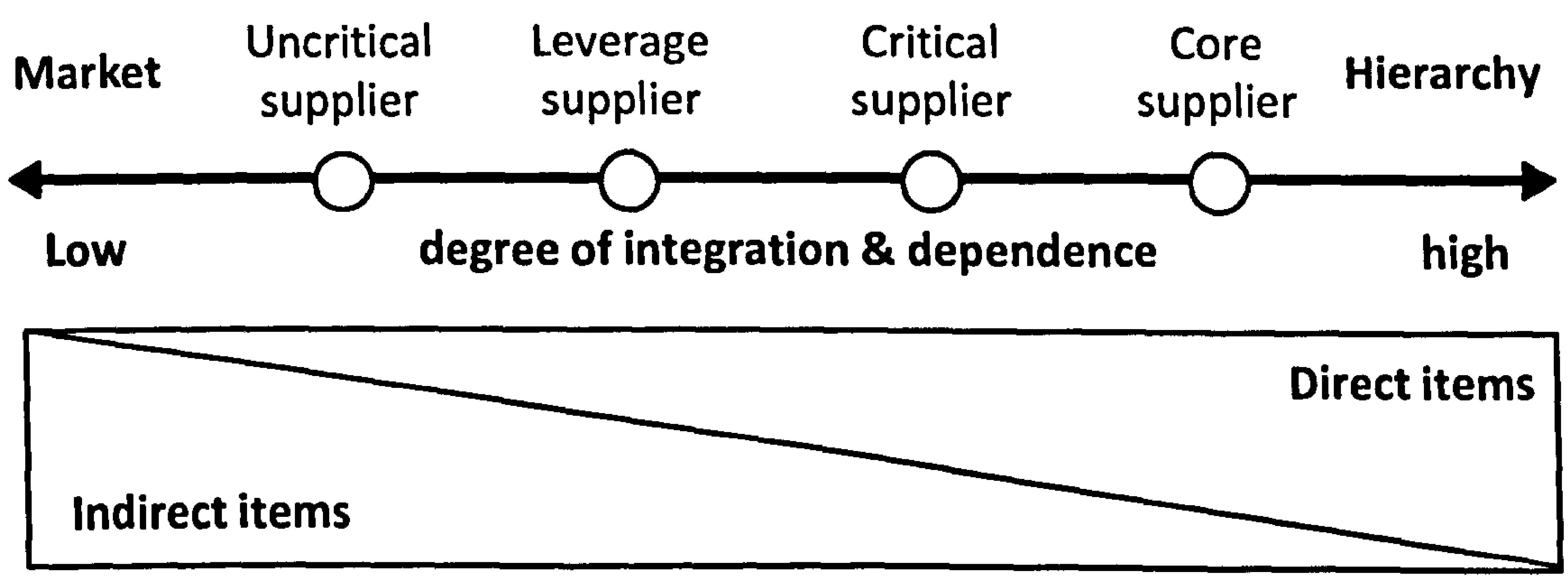


Figure 37: Supplier categories with their degree of integration and dependence

For a non-critical supplier there will be not much attention from the purchasing department, except to assure a minimal administrative effort to handle an order. Examples are maintenance repair and operation goods (MRO) or stationery supplies. Leverage suppliers are invited for competitive bidding with a long contract duration based on the expected volume. This is applicable, for example, for work wear or production consumables like welding gas. In the group of critical suppliers belong those 20% of suppliers that constitute 80% of the total purchase spend (Kauffman 2001). Here we will find suppliers for direct material where the development for long-term partnership is necessary. Suppliers for investment goods or machine tools fall in this category too.

When approaching or "managing" a supplier, the buyer's negotiating position is vital. SMEs in the manufacturing sector are often in a "powerless" (Christiansen & Maltz 2002) position when negotiating with large suppliers, for example, when buying welding gas or electricity. This is in particular true for companies offering only sub-contract manufacturing service. However, the evaluation of suppliers within the current portfolio and their potential are important, for example, concerning future outsourcing activities of current core business or for streamlining customer requirements. The following criteria give an estimation of the current supply situation (Kraljic 1983):

- Market size vs. supplier capacity: Large suppliers obviously tend towards a monopoly dictating the price.
- Market growth vs. capacity growth: Few suppliers in a fast growing market have a strong negotiation position.
- Capacity utilisation or bottleneck risk: Supplier or market intelligence is necessary to determine actions when reaching the maximum capacity and not risking a bottleneck causing shortage. Unfortunately, alternative materials are not always an option.
- Competitive structure: Large companies holding a major market share with several suppliers have a strong position.
- Break-even stability / cost of non-delivery: What would be the cost of a process change related to a supply source change?

- Uniqueness of product and technology stability: Suppliers with unique products have a strong position.
- Entry barriers (capital and knowledge requirements): Make-or-buy decisions?
- Logistics complexity: How much would be the cost of a delivery failure and a necessary "DIY" (Do-It-Yourself)?

Some points mentioned above are not valid for the purchasing process of SMEs but useful when considering the sales side of large suppliers. Companies concentrating more and more on the core business also rely increasingly on quality suppliers. This reliance on a few core suppliers is important because:

- The development of mutual trust is a prerequisite for successful cooperation but can be lengthy and time intensive;
- The alignment of procedures, workflows, working culture and other company specifics is a ongoing process (Figure 5);
- A higher turnover with few suppliers should decrease prices and mutual dependency is not a one way but has to be monitored;
- Of possible future integration of ICT systems.

The initial categorisation of suppliers is very similar to the purchased items themselves (see 4.5.1) supplier relations are characterised by:

- Type (long and short term, strategic, core or MRO) and competitive alternatives;
- Satisfaction established by quality, in-time-delivery, lead time, responsiveness, flexibility, willingness to co-operate, commercial reliability/pricing;
- Annual turnover.

There is the argument of supplier dependence in single sourcing partnerships (Cousins 1999). First, a sole supplier for a particular item should consider the higher volume at a lower price. This is the primary driver for a company. In the case of disagreement with the current supplier an item that is in accordance with a common standard will have a cost associated with switching the supplier (Heijboer 2003) that should be outweighed by the benefit of enjoying a "sole supply" previously. Otherwise, a de-complexing of the design or requirements should be considered (Gelderman & van Weele 2002). For complex items that cannot be changed easily the alternative to a sole supplier is to maintain per supplier an additional stream throughout the entire product lifecycle. Realistically, this is occurring many times and the total of additional lifecycle costs is difficult to estimate, for example, a company that has many printers from many different manufactures. On the other hand, dual sourcing is supported by an increased variety of design alternatives, higher availability of critical supply, ongoing price competition and obviously less dependence on one supplier (Akacum & Dale 1995). For an assessment of a supplier the following field structure is a good starting point (Table 10):

o Rank	o In-Time-Delivery
o Name	o Flexibility / Co-operation
o Turnover	o Commercial Reliability / Pricing
o % of purchases	o Cost Reduction Target
o Purchase categories	o Extent of influence (Market position)
o Goes into which own product	o Total Supplier Rating
o Critical Level	o Notes / Activities with Supplier
o Quality Level	
o Lead time	

Table 10: Metrics for continuous supplier assessment

When analysing suppliers the following approach is helpful for an initial relation assessment (Kauffman & Wang 2001). After analysing product groups related to suppliers a separation line of can be set at about 3% of the annual spend. The position of the vertical line is separating up to 3-4 suppliers as "strategic" and related to the ability to substitute a material / product, competitive situation (Figure 38 right).

To summarise the management of suppliers, two areas, competition and performance metrics have to be considered. Whereas the analysis of general external competition and supply market will provide a long-term strategic framework of relations, the second criteria, performance metrics, will contribute towards the operational work with suppliers.

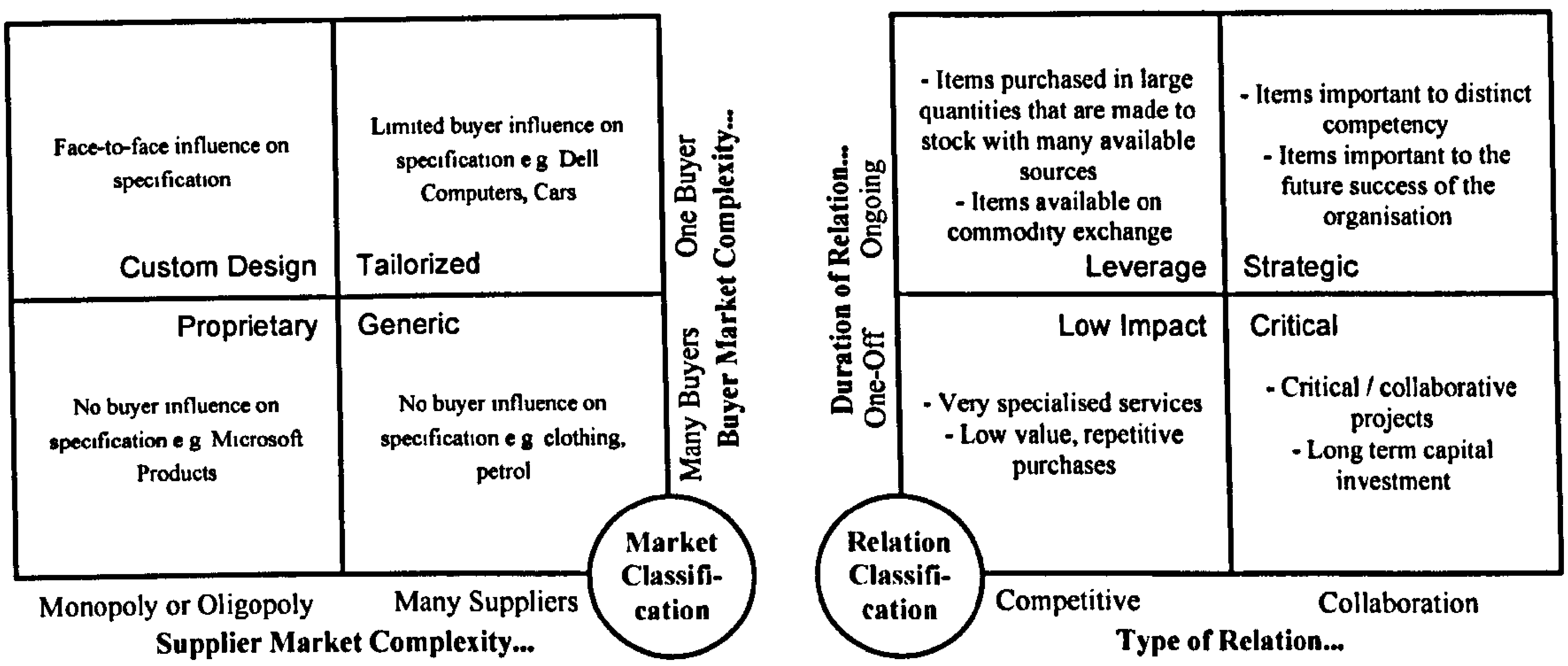


Figure 38: Supplier classification depending on market position and relation (Kauffman & Wang 2001)

4.6 SUMMARY OF THE CHAPTER

What are the necessary considerations regarding the purchasing function within an individual SME?

Based on preliminary research, which was predominately investigating large organisations, this chapter develops a set of ideas and rules forming a new framework for the purchasing function how SMEs should put business processes into the SCM context (Figure 25) by linking corporate strategy (Figure 27) and management with metrics of individual items and related suppliers. Large companies model the entire supply chain; SMEs need a framework to master their own position.

For the development of a consortium and in particular aiming at collaboration in purchasing all participating companies have to be conscious of the main purpose of the purchasing function to align their operations and culture. Staff and senior management of many organisations have to be involved on a level of mutual trust, which is only possible to achieve through a multitude of mutual activities over time. Related with the development and deployment of a purchasing consortium is the progress of the level of mutual trust amongst participating companies and towards the consortium itself.

However, a research as presented in this thesis investigating industry related problems has little influence to accomplish the actual organisational readiness. This is a long-term process, as described in Chapter Seven. Nevertheless, this framework is applicable considering any manufacturing SME, which will be part of a supply network.

This chapter reviewed influencing factors for purchasing; starting from strategy through to the purchased items itself, altogether, forming a novel framework comprising:

- Metrics concerning the business strategy (Figure 27 and Table 4);
- Managerial time horizon of the purchasing function (Figure 29);
- Considerations for individual items and suppliers.

The first important conclusion for the purchasing function is: no method is the best (Pearcy et al. 2004); it all depends on the product lifecycle stage of the products and services (Table 6). Secondly, many of the comments might be obvious for a company that has been in business for many years, but SMEs are normally not in a position to dictate actions to suppliers. Hence, in a changing business landscape a collaborative purchasing approach seems to be useful.

Usually, the priority of every company is to sell products and services to generate income. Necessary part of the involved value chain is the purchasing function, which assures the required supply. Hence, there is a *short-term* focus on the administrative, executive and clerical part of the purchasing function within many SMEs. A collaborative consortium can offer support by providing web based purchasing software (as described in Chapter Six). *Medium-term* tasks to maximise the possible impact of the purchasing function relate to optimise current supplies. This includes the systematic monitoring of supplies, the classification of items and striving towards cross-departmental involvement; an increasing managerial involvement is necessary. The *long-term* part of the purchasing function embeds into the corporate strategy by aligning customer requirements with supplies. Considerations require deep customer requirement knowledge and in-depth supply market information. A framework such as SCOR (Supply Chain Operations Reference model) in conjunction with metrics can provide ideas for SCM. Within many SMEs, this requires the management, represented many times by company owners, to consider purchasing and supply chain knowledge.

In this chapter many recommendations, rules and ideas for parameters characterising the purchasing process were given. Data collection is crucial to enable decisions based on knowledge rather than ad-hoc fire fighting. This tedious task is often neglected due to emerging operational priorities. However, an evaluation of achieved business goals can only be made based on historical collected data instead of a summarised conclusion "No, we did not make profit last month!" which is an unfortunate reality in many small firms to date.

5. APPLIED ICT FOR PURCHASING COLLABORATION

To put the procurement framework (Chapter Four) into collaborative practice the application of ICT within a consortium has to be explored. This chapter develops a concept on how to implement a centralised infrastructure that enables individual companies to collaborate.

The first important pre-requisite for any procurement transaction is the availability of product information. Obviously due to changing parameters such as specification, price, and availability the responsibility to provide this information should be left with the supplier/manufacturer. For electronic procurement purposes sources such as databases, XML files or real time access to ERP interfaces are popular choices. These considerations seem to be missing in strategies of many SMEs, and were stated in only 25% of those considering e-business (Quayle 2003). Here, collaboration can be a cost effective and risk reducing approach.

Secondly, data specifying the purchase item characteristics has to be exchanged and processed, requiring common method and protocols. This requires a collaboration enabled ICT infrastructure of all participating companies.

The third component comprises the procurement workflow steps necessary to reach an agreement between involved parties including, for example, Request for Quotation (RFQ), price comparison and authorisation.

Finally, these workflow steps can be integrated into local ERP systems, stand-alone e-procurement or a web based solution, enabling all involved parties to access real time information.

5.1 CONNECTING ERP "ISLANDS"

Economic growth of SMEs depends very much on the adoption of e-commerce and as part of it e-procurement too. The larger non-SMEs and multi-nationals with e-procurement systems in place are only interested in conducting business with organisations with compatible electronic systems. This research is designed to develop knowledge in the field of e-procurement for the consortium member organisations over time.

Recent advances in computer and networking technology have lead to significant progress in electronic communication and data exchange. Email and networked information sharing have become an integral part of many companies, as has the utilisation of the Internet for information acquisition. Future forecasts indicate a significant take up in electronic B2B transactions (Attaran 2001, EUROSTAT 2005).

Unfortunately, from an inter-organisational perspective, there are still not many cases where companies benefit from networked information systems. In particular, the current level of electronic inter-organisation data sharing and exchange amongst SMEs is rather theoretical than a reality (Stefansson 2002). Long-term participation is essential for the success of collaborative inter-organisational research projects and such initiatives can only be achieved by providing short and long-term benefits as described in Chapter Seven.

Companies have always communicated with each other, but the technology that carries this communication is constantly changing, from telephone, fax, email to EDI or XML based technologies. Today, most of the communication is carried out through Internet based technology – including a telephone conversation, which is normally not recognised by the user.

There are many alternatives for SMEs to exchange procurement data. For the purpose of electronic inter-organisation collaboration, the scenarios shown in Figure 39 can be applied. Many companies use ERP or equivalent software systems to manage the schedules of several simultaneously running projects and related purchases (see Figure 45). Such procurement demand lists, created by ERP software, might be sent out from an SME acting as a buyer to several suppliers in various forms such as fax, email or Excel/plain-text/XML-file. The immediate ability to process the returned quotation requires compatibility of the company's ERP system and the supplier's quotation ERP/sales module, or else considerable manual intervention is necessary. A comparison of the received quotations will be made manually in SMEs. On the other hand, there will be simple orders with an approved supplier in many cases without any negotiation.

Figure 39 shows a data transformation system, which allows especially for SMEs to operate with the required flexibility. When conducting purchasing electronically, within the scenario below companies can (a) use the procurement web client (see chapter Six), (b) their own ERP system in conjunction with the e-translator (see 5.2), or (c) set up their own e-translator system. All three options include the choice of collaboration with other members of the consortium. In either case, many purchases may not be completed utilising the local ERP system, but instead web shops, fax orders or onsite product catalogues.

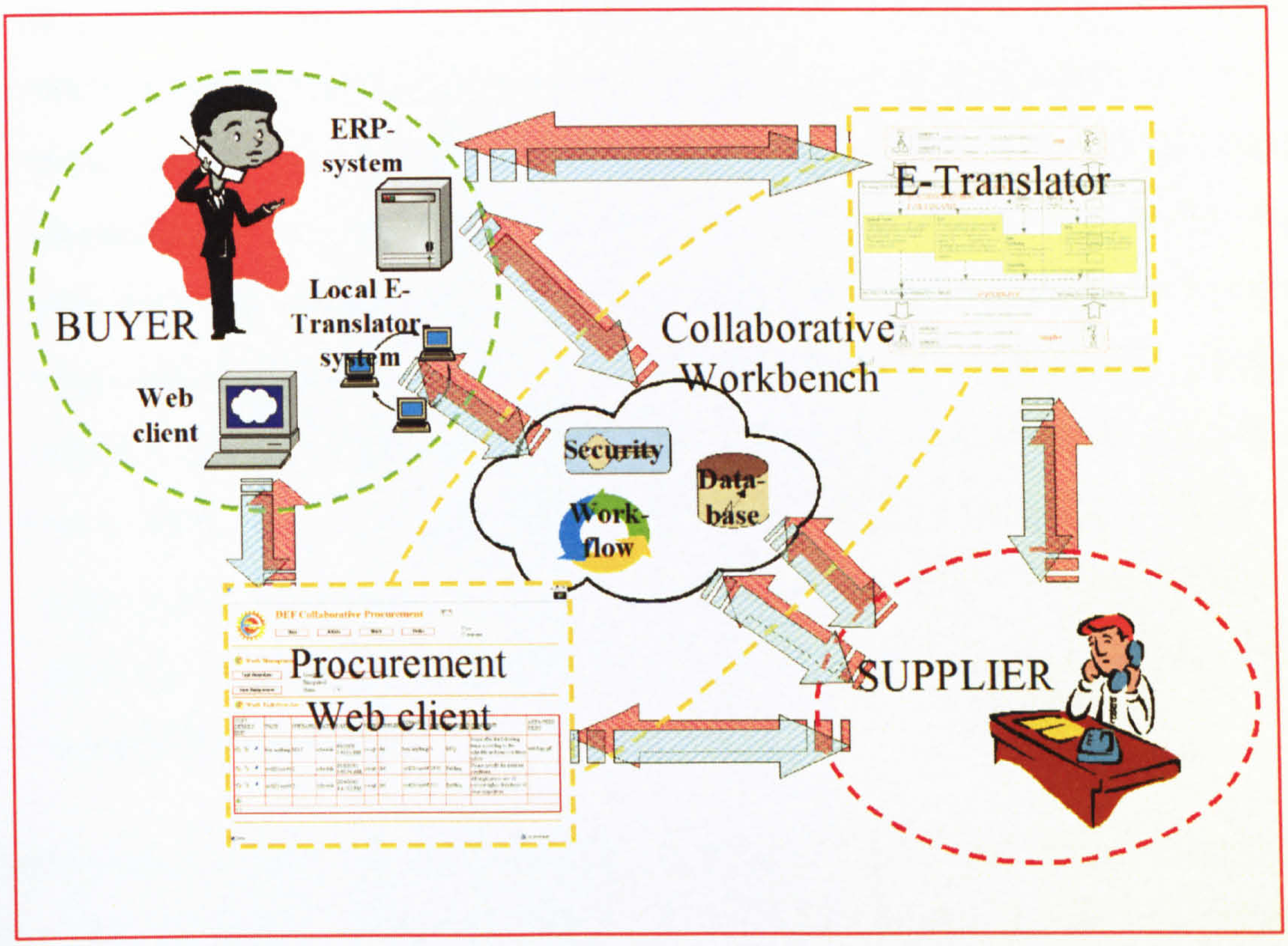


Figure 39: Inter-organisation collaboration the scenarios

Figure 39 above reflects possible scenarios for IT based communication between buyer and supplier in the collaborative context of this research. For participating companies there are three possible interfaces:

- Local ERP system: Export/import interfaces of a local ERP are used for procurement data handling. This data is sent to the e-translator module (see 5.2), which is responsible for the mapping process to fit the partners' data format. When using the option Collaborative Workbench demands will be public and visible within the Procurement Web Client for collaborative demand aggregation.
- Local e-translator system: A company with several independent branches or subsidiaries can establish an individual collaborative system but also collaborate on a larger scale (e.g. by connecting local e-translator systems). A local e-translator system should be able to match

any partner's data format; however, demands sent to the Collaborative Workbench are public within the consortium for demand aggregation.

- Web client: Small companies can develop their own procurement database on the collaborative workbench when the ICT infrastructure on site does not support the procurement process. Furthermore, because of high administrative costs it is not worthwhile to maintain cheap or seldom bought individual items on a database. Companies can benefit here from demand aggregation and one-off administration as well. The high-order functions of the procurement web client are to control the process of demand aggregation, to govern the access security and to support the workflow.

Within this project, collaborative procurement has to be demand driven and for that purpose, demands have to be announced to the participating partners. These single company demand lists can be submitted to a procurement hub or fed manually using the procurement web client. Compared with a simple fax order this might be an additional effort, but considering the utilisation by other partners this will lead into a group demand aggregation and specialisation of involved partners. Utilising the procurement web client developed within this research (Chapter Six), the decision whether a demand is eligible for collaboration and aggregation has to be made when submitting it to the consortium hub. Subsequent collaborative, individual companies' and suppliers' workflows can be completed utilising the collaborative procurement software prototype. Depending on individual partners' software solutions the procurement work steps exemplified below can also be executed with local ERP or equivalent software using the e-translator module (see 5.2) of the collaborative procurement hub. This means export/import communication with the hub will be possible for each "data triple status" (Figure 47) of the procurement workflow.

The purpose of an inter-organisation information system (IOIS) in the context of this research is to improve the management of existing supply chains by providing information. Immediate available information of the current work or project status within other organisations will improve the readiness of their own organisation resulting in a shorter response time. This can be considered as the strategic deployment of IT to obtain competitive advantage as this level of integration is very rare in industry to date.

An increasing reliance on outsourced network activities has been recognised (Tan 1998) and at the very least, close integration with ERP/MRP is necessary. Current capabilities of most SME to provide information automated and digital are limited but the rapid growth of the Internet in the past decade will continue to enable most SMEs to exchange real time information with partners by using, for example, broadband connectivity to run in-house web servers.

The justification for setting up networks is supported by the recognised advantages of supply chain instead of individual head-to-head competition (Magretta 2002, Stock et al. 1998). However, for an individual company, the driver to participate in IOIS will be increased effectiveness, efficiency and finally cost reductions, too. Another important driver for developing inter-organisation information systems is the pressure to which a company is subjected by their competitors and large prime contractors. The organisational readiness will not be achieved over-night but prerequisites might emerge rapidly with changing customer requirements.

The previously mentioned inter-organisation information systems are difficult to implement into SMEs. Inhibiting factors are certainly financial and, from a technology management point of view, the Return on Investment (ROI) is very difficult to judge for new emerging technologies. Keeping an overview of relevant novelties is hardly feasible but equally difficult is the assessment on implementation cost and benefit. Here, a limiting factor with regards to technical capabilities of many SMEs is reached. On the other hand, information sharing always bears the risk of misuse and leaks exploited by competitors. Finally, a big inhibitor for IOIS adoption is inner-organisational resistance to change.

Figure 40 summarises the described issues influencing the implementation of an inter-organisation information system supporting supply chain activities of SMEs (Morrell & Ezingeard 2002).

Hence, many SMEs continue to conduct their normal business with no ambition to change.

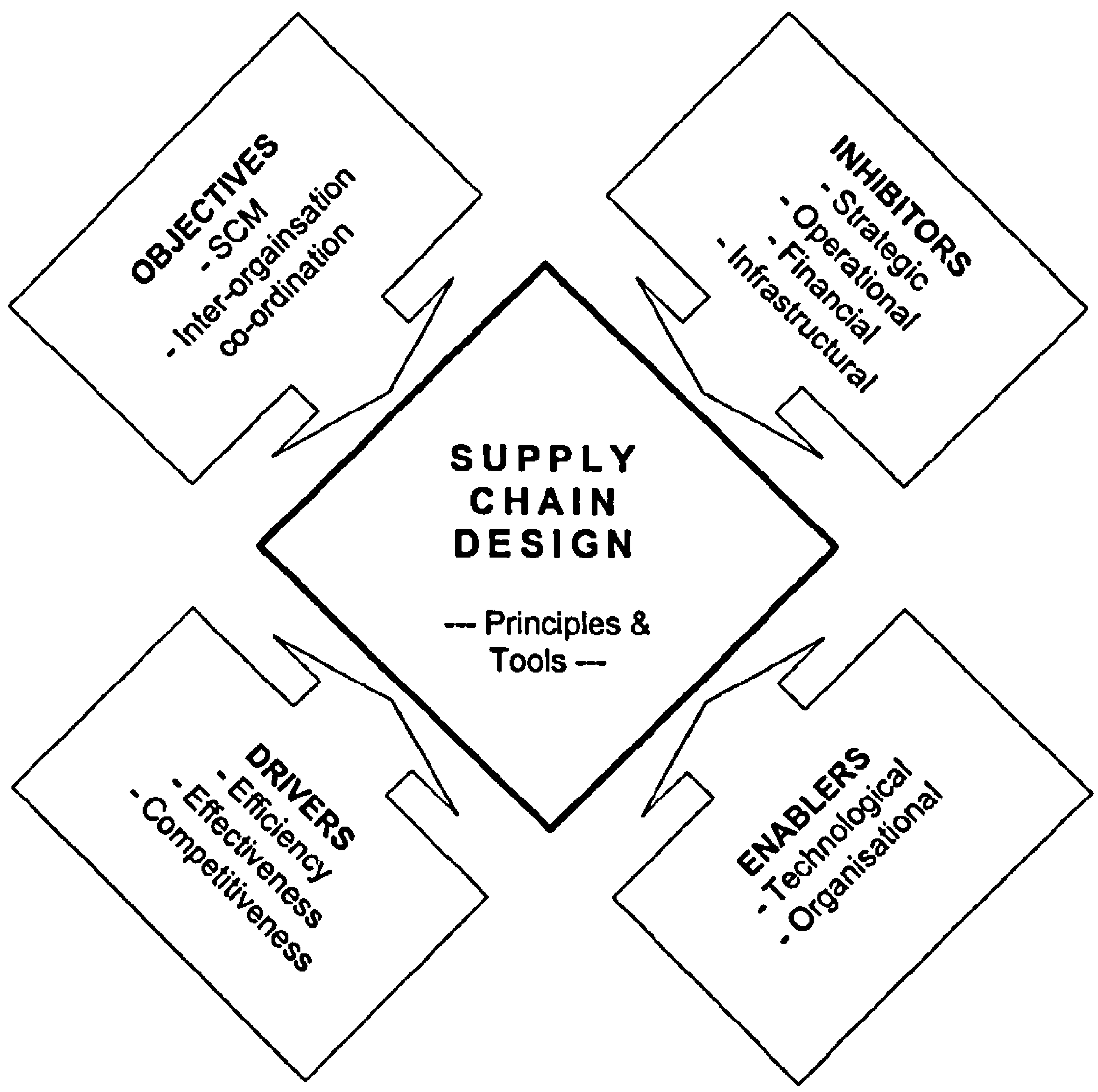


Figure 40: Success factors for IOIS deployment in the context of supply chain design (Morrell & Ezingeard 2002)

5.2 Development of an E-Translator Model

The e-translator model was developed to increase the adoption of electronic procurement and enable inter-organisation collaboration within a SME consortium. Designed to perform a holistic appraisal of purchasing workflow within individual organisations, the translator offers a new approach to exchanging data, especially in the field of procurement. The IOIS-software will be capable of handling both inter-organisational collaborative electronic procurement processes and single organisation requirements.

Key to the system is Microsoft's BizTalk server, operating with other .NET servers, such as Internet Information Server (web server), SQL Server (Database server) or Internet Security & Acceleration Server (Firewall server). The main function of the e-translator is the automation of information exchange. XML technology will be utilised wherever possible. For modelling the procurement process, a micro and macro philosophy has been adopted. The micro philosophy describes the procurement workflow itself (see also Chapter Six) and the macro philosophy breaks down the inter-organisational business scenarios as follows below.

Good communication is a pre-requisite for successful inter-organisational collaboration. The key to collaborative procurement is the identification and aggregation of the partner company's demands. As described earlier the procurement process involves the following steps: 'Plan-Source-Buy-Move'. This KISS approach (Keep It Simple and Straightforward) was chosen to deliberately relate the research with SCOR (Supply-Chain Operations Reference-model) and expand purchasing activities towards supply chain management methodology as a steady learning process for many of the very small participating companies.

For the purpose of collaboration, it was necessary to introduce a choice field offering partners the opportunity to participate in the collaboration of individual items. Due to the complexity of individual technical requirements or the diverse supply base it is unlikely that an optimum level of demand will be identified at the first phase, but alignment in the next phase is possible assuming further communication and co-ordination of the participating companies. Standardisation of demand across the group of independent companies is a long-term undertaking. Examples of data could include:

- an organisation's monthly demand on metal sheets;
- CAD training needs for staff.

The selected items will originate from either the companies/suppliers local ERP system or the e-translator database. Depending on the interaction necessary with local ERP systems, a data exchange with the e-translator is possible at all stages of the procurement workflow, for example, an order is divided into several part deliveries which have to be synchronised with local systems. Apart from pure e-translation processes, data for all items purchased collaboratively must be submitted to the e-translator procurement workflow. Companies can handle individual and collaborative purchasing processes. The difference between the collaboration processes and individual processes is a further sub-process where demand aggregation is visible.

A process complication could arise due to individual organisations withdrawing or changing demand during the process. However, the work involved in re-negotiation and agreement is relatively small compared to the benefits gained through the reduction in process time of a 'bulk purchasing' operation. Furthermore, the electronic workflow reduces reaction time significantly (NePP 2004).

Looking beyond operational procurement processes there are several business scenarios in which the e-translator could be applied. Within the procurement process for inter-organisation collaboration, there are four case scenarios to consider when employing the e-translator with changing complexity and requirements.

Figure 41 highlights the four basic business scenarios or modes of operation. Setting up inter-organisation information systems is a complex process; hence, it reaches beyond 'simple' tasks. In the following considerations:

- 'medium' complexity reflects the work with standard system components;
- 'high' complexity tasks require custom programming;
- 'very high' complexity tasks involve several companies' ICT systems.

1. Case DEMAND/ORDER: An organisation submits regular demands to the e-translator. The data is matched to the suppliers' format and posted. Knowledge of the data formats of source/target is necessary and need to be provided by the participants. This scenario is using the procurement process of the collaborative purchasing software (Chapter Six), useful for handling regular occurring data or repeat orders such as raw material or paint. Work involved in setting up the system is considered 'medium', for example, integrating a few core suppliers to the hub.

2. Case EAI (Enterprise Application Integration): As with the DEMAND/ORDER scenario there has to be initial agreement between partners. However, due to the system-system integration between the partners, the implications go much further. To achieve an optimum level of responsiveness to customer demand it is necessary to visualise a partner's process data containing demands. To progress from collaborative inter-organisational procurement towards supply chain management it may be necessary to have direct access to a partner's ERP system. An in-depth

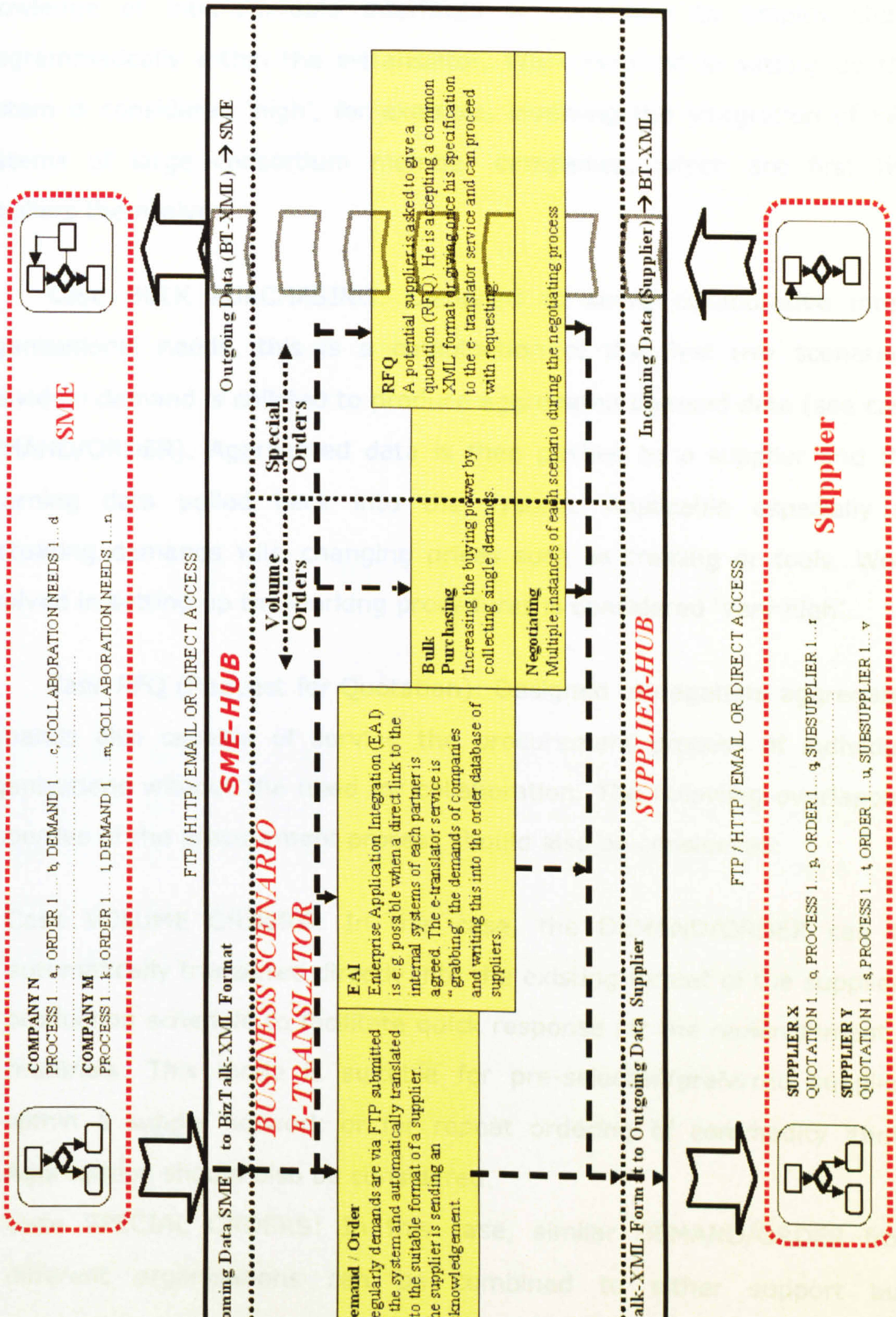


Figure 41: E-translator business scenarios

knowledge of inter-operable interfaces is necessary to employ them programmatically within the e-translator. Work involved in setting up the system is considered 'high', for example, involving the integration of ERP systems of large consortium member companies, which are first tier suppliers themselves.

3. Case BULK PURCHASING: Designed to serve collaborative inter-organisational needs, this is a combination of the first two scenarios. Individual demand is collated to produce aggregated demand data (see case DEMAND/ORDER). Aggregated data is then pushed to a supplier and the returning data pulled back into the system. Applicable especially to fluctuating demands with changing prices such as training or tools. Work involved in setting up the working procedures is considered 'very high'.

4. Case RFQ (Request for Quotation): Designed to negotiate aggregated demands also capable of serving the procurement process of individual organisations without the need for collaboration. The following overlapping properties of the procurement process should also be considered:

- Case VOLUME ORDERS: In this case, the DEMAND/ORDER can be automatically translated directly into the existing format of the supplier's production schedule to facilitate quick response for the replenishment of materials. This mode is suitable for pre-selected/preferred suppliers within a supply network or for repeat ordering of commodity items. Aggregation should also be considered.
- Case SPECIAL ORDERS: In this case, similar DEMAND/ORDER from different organisations can be combined to either support bulk purchasing or be posted to a range of pre-selected suppliers with the required manufacturing capabilities. A trend towards mass customisation combined with business innovation will increase the percentage of orders related to customised items. This case supports business processes containing high-value items that require intense negotiation to improve responsiveness within the supply chain.

- Case NEGOTIATING: Negotiation is essential in the procurement process particularly for special orders and establishing the initial agreements for the case DEMAND/ORDER and EAI.

There are many scenarios to consider when developing electronic procurement software; a consortium of manufacturing SMEs is very similar to a large organisation operating with local branches or divisions and information will be exchanged applying a push or a pull approach. A detailed description of the collaborative purchasing process is given in Chapter Six.

5.3 SECURITY FOR COLLABORATIVE ICT

SMEs exchanging information with partners ensure security through an extranet, which is usually a web based private network connecting suppliers, customers and partners. The range of applications spans from sales/purchasing, manufacturing, design, videoconferencing or simply file sharing. Everything is managed within an IOIS; secure communication is imperative for co-operation. Only permitted users (for example, staff, programs or servers) may access assigned resources (for example, files, programs or services). This process is implemented through authentication and authorisation. Before utilisation of any resource, there should be a verification of the identity of a person or process, which is called authentication. Subsequent authorisation to use a resource is granted or denied by the IOIS. This is a customised process depending on the rights assigned on the authenticating server and the application itself.

Only very small companies do not apply Internet access control rules, but concerning the access from the outside the local network must be protected. This is achieved through dedicated firewall hardware in conjunction with software. The task of a firewall is to act as a gateway between networks based on a custom rule set. This can be for example a request to use internal resources or just to send a RFQ file. When matching at least one rule the data is treated accordingly, if not data is dropped or rejected (depending on the individual set up of the firewall).

In general, this authentication is required; the most popular exception is the operation of a web server. Here a firewall must allow anonymous requests of data, otherwise, for example, marketing information on the company's web server cannot be viewed by everyone. Depending on the requirements, other applications must be incorporated into the firewall rule set, which is fairly straightforward when applications are deployed using standard ports. A port can be considered as an end point of a logical connection for different protocols to communicate on different machines. Hence, a firewall tests arriving data with regard to which application is requested and if authorisation is required. Actually, the data communicates with the firewall on a port that indicates the application itself. A firewall either duplicates the authentication database or communicates with an appropriate server such as Microsoft Windows 2003 Server. If authorisation is granted based on the rule set, the firewall forwards the request to the appropriate source.

More complex is a scenario requiring secure communication between organisations where unauthorised users or applications must not have access. In the past, this was assured through separated networks with a dedicated physical infrastructure. Those "leased lines" are obviously very expensive and recently outrun by Internet technology using VPN (Virtual Private Network). A "virtual" private network is in reality using the public Internet infrastructure and assuring privacy through encryption. Connecting two local networks there are two devices necessary, one is encrypting data for transmission and the second is decrypting which is called "tunnelling".

5.4 SUMMARY OF THE CHAPTER

What are the considerations for a non-profit intermediary consortium to deploy the necessary ICT infrastructure to support the collaborative procurement process of a group of SMEs?

Business consultants, marketing experts or academics are very creative in inventing new jargon to justify their existence and ensure continued insecurity. In the context of SMEs, the process of information technology change and related business adaptation is very slow and cautious. On the other hand, this is partially due to the complexity of available standards itself as they cover all possible scenarios. This stresses available resources within SMEs as compared with their potential benefit towards business priorities (Johnston et al. 2007).

Collaboration from an ICT perspective implies the exchange of information. This includes the identification, extraction from a local system, exchange, and import into a partners system or translation into appropriate readable format (Figure 41). This is simply outside the financial budget or beyond internal resources and considering the strategic priorities of SMEs (Chapter 4.2) many collaborative ICT projects cannot be justified by providing a positive impact on the accounts. In procurement, product features and price information have to be exchanged, and in a collaborative scenario stored to be accessible for all participants (Figure 42). Realistically, only a centralised model can be considered within this research, otherwise a programmatically integration with the Internet enabled ICT systems of many suppliers or significant manual data re-entry would be necessary. Even the provision of an on-site multi-vendor catalogue system is very advanced and the availability of data provided by suppliers is a pre-requisite. However, when starting this collaborative project this was not the case and only the development of a gradually growing database will be possible within the collaborative purchasing software prototyping phase (Chapter Six).

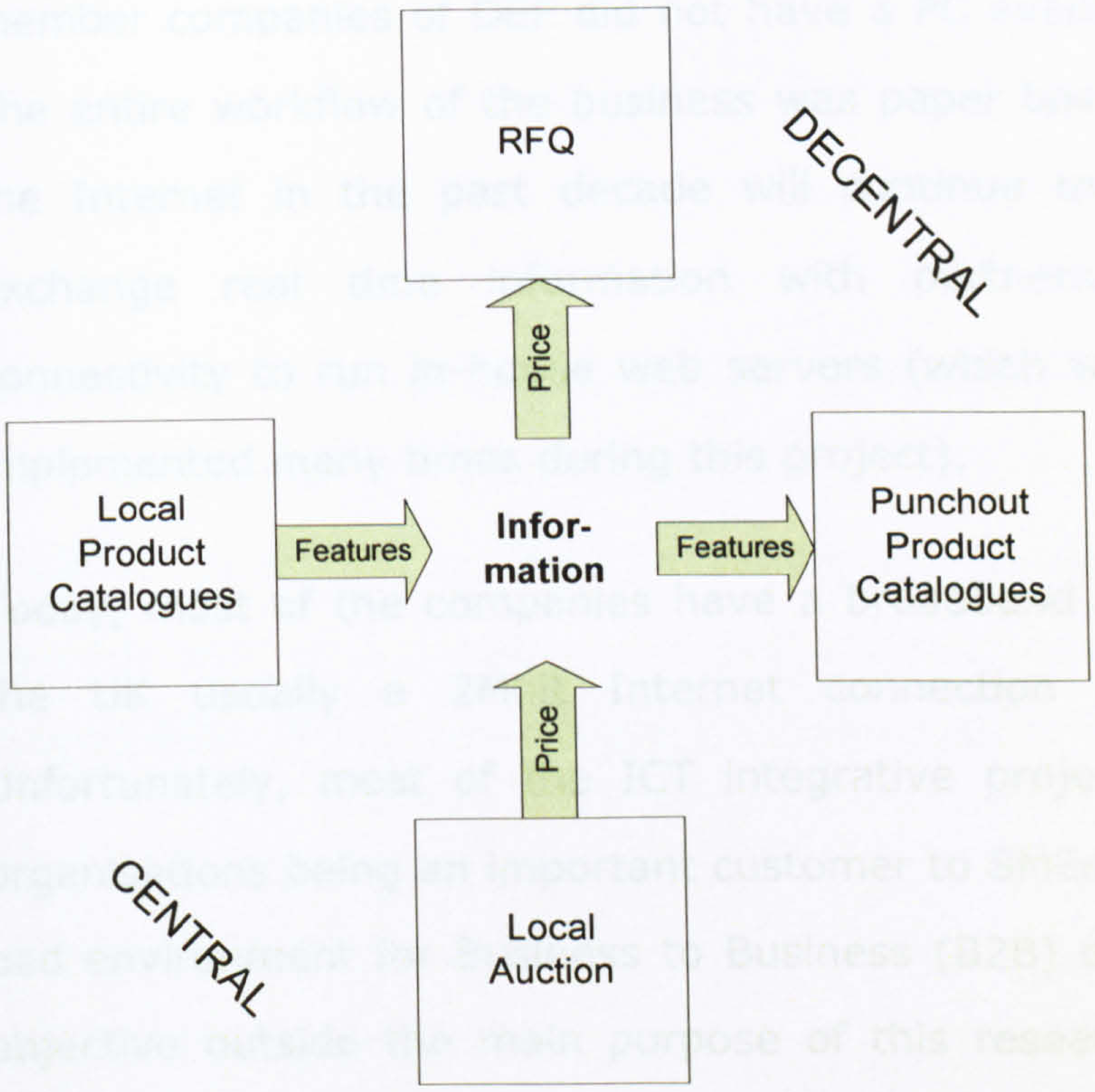


Figure 42: Principles of product feature and price information exchange

Due to the differences in ICT solutions supporting the procurement process, it may be necessary to provide some form of data translation. This can be achieved by integrating an import/export module with the inter-organisational collaborative electronic procurement software (Figure 39 and Figure 41). This solution constitutes a very high level of inter-organisation collaboration and is not yet a common standard. The development of a collaborative procurement solution requires changes in:

- The supply chain decision processes;
- The organisational behaviour amongst participating companies;

- ICT system openness (especially import & export functionality) and standards.

Current capabilities of most SMEs to provide information automated and digital are limited. When starting this research in autumn 2000 several member companies of DEF did not have a PC available within their offices. The entire workflow of the business was paper based. The rapid growth of the Internet in the past decade will continue to enable most SMEs to exchange real time information with partners by using broadband connectivity to run in-house web servers (which was actually advised and implemented many times during this project).

Today, most of the companies have a broadband subscription, which is in the UK usually a 2Mbit Internet connection (date: summer 2006). Unfortunately, most of the ICT integrative projects are driven by large organisations being an important customer to SMEs. The provision of a test-bed environment for Business to Business (B2B) data exchange is another objective outside the main purpose of this research: the development of collaborative procurement prototype software (Chapter six).

Novelty of the remarks made in this chapter relate to the development of collaborative ICT infrastructure of a consortium by considering current state of the art solutions on a shared basis. Anticipating future trends of business execution software (Figure 22) a solution to support integration and communication of individual companies' ICT systems was introduced (Figure 39 and Figure 41); here the focus is on collaborative purchasing. Similar to considerations of SCM: SMEs should concentrate on implementing and mastering state of the art ICT, which provides all functionality necessary for collaborative purchasing; the scientific development of new information technology remains domain of special projects.

6. DEVELOPMENT OF A COLLABORATIVE PROCUREMENT SOLUTION FOR SMES

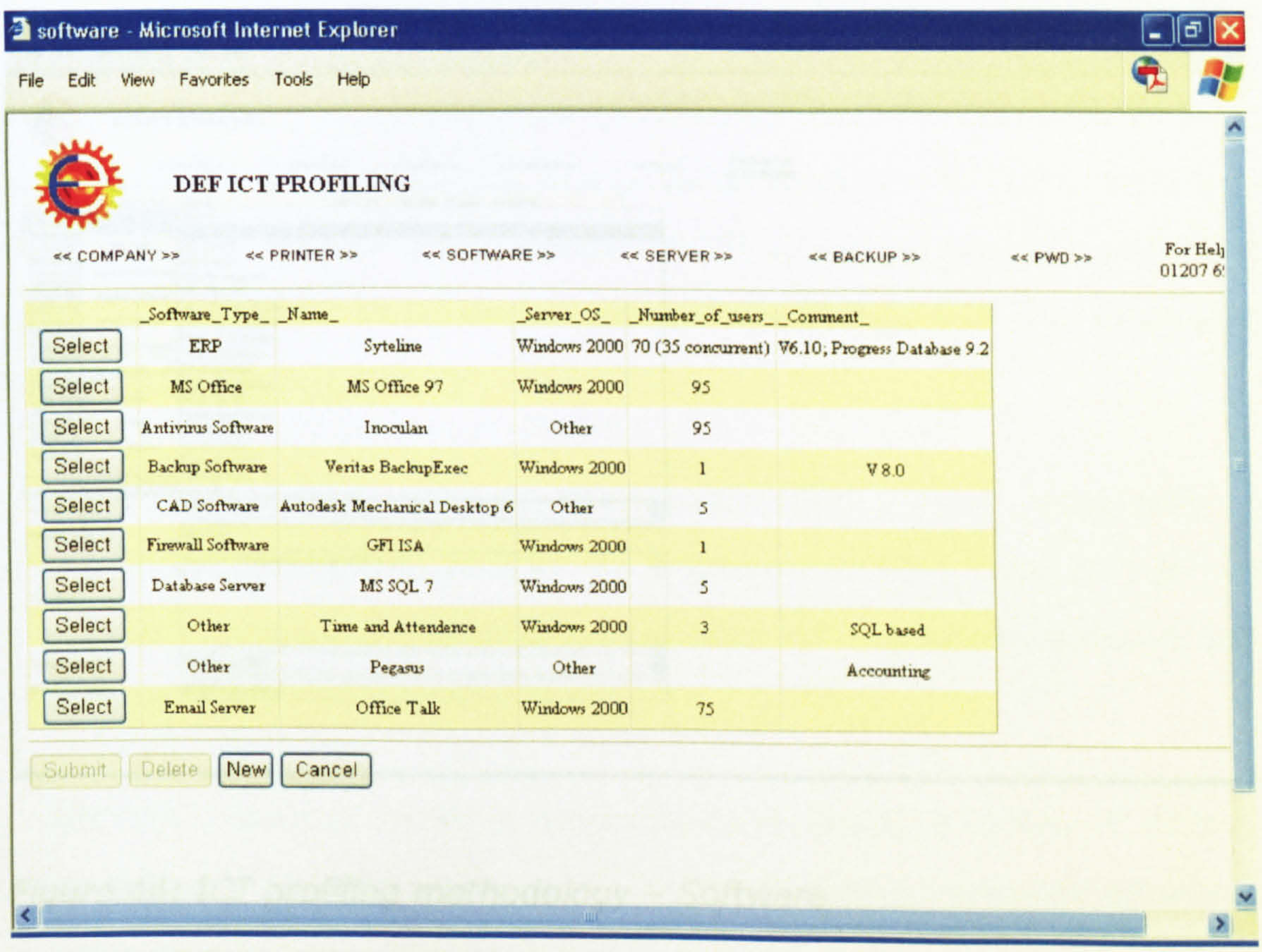
Chapter Four developed a procurement framework for SMEs. Chapter Five summarised the ICT environment for collaboration in purchasing. In this chapter, based on within the consortium available ICT solutions, the development of a collaborative procurement workflow and collaborative procurement prototype software is demonstrated.

6.1 ICT SURVEY

An online survey was undertaken with the purpose of investigating the level of ICT adoption amongst consortium member companies. Its primary purpose was to support the "Crisis Management Initiative" (see 7.2) but also to provide enough information for future electronic purchasing systems integration.

The role and function of ICT within the process and collaboration model, especially in the field of procurement is elaborated in Chapter Five. The availability of current collaborative demand information is considered as critical when negotiating with suppliers. Moreover, it is obvious that the systematic process of collaborative demand aggregation cannot always be undertaken manually (as initially attempted in 7.3.4). Hence, as a first step a tool to automate this process of demand aggregation is required. Subsequently, a further integration of relevant information systems used by individual companies can be considered.

Preliminary work is required to investigate into employed ICT systems within individual companies and equally important to develop personnel relations and trust with the IT staff. Therefore a web based form was developed (Figure 43) and introduced during an individual session with each company. The attempt of having a training session at the consortium office was made but has proven unsuccessful due to high workload and emerging operational tasks to companies. As a result, the ICT questionnaire was completed on site when visiting premises and examining local ICT facilities.



	_Software_Type_	_Name_	_Server_OS_	_Number_of_users_	_Comment_
Select	ERP	Syteline	Windows 2000	70 (35 concurrent)	V6.10; Progress Database 9.2
Select	MS Office	MS Office 97	Windows 2000	95	
Select	Antivirus Software	Inoculan	Other	95	
Select	Backup Software	Veritas BackupExec	Windows 2000	1	V 8.0
Select	CAD Software	Autodesk Mechanical Desktop 6	Other	5	
Select	Firewall Software	GFI ISA	Windows 2000	1	
Select	Database Server	MS SQL 7	Windows 2000	5	
Select	Other	Time and Attendence	Windows 2000	3	SQL based
Select	Other	Pegasus	Other		Accounting
Select	Email Server	Office Talk	Windows 2000	75	

Figure 43: ICT capabilities online questionnaire

The questionnaire (see Appendix C), developed using Microsoft VB.NET has the following sections:

- General company information;
- Printer: brands, format types and print volume;
- Software (Figure 44): software type, internal identifier, comments, operating systems, number of users. Further important classifications of used software are made into ERP systems, CAD, Backup, Firewall, Database, Email, Fax, Antivirus and other;
- Server: server name, operating system, backup media, hardware specification;
- Backup: server name, software, cycle, data volume.

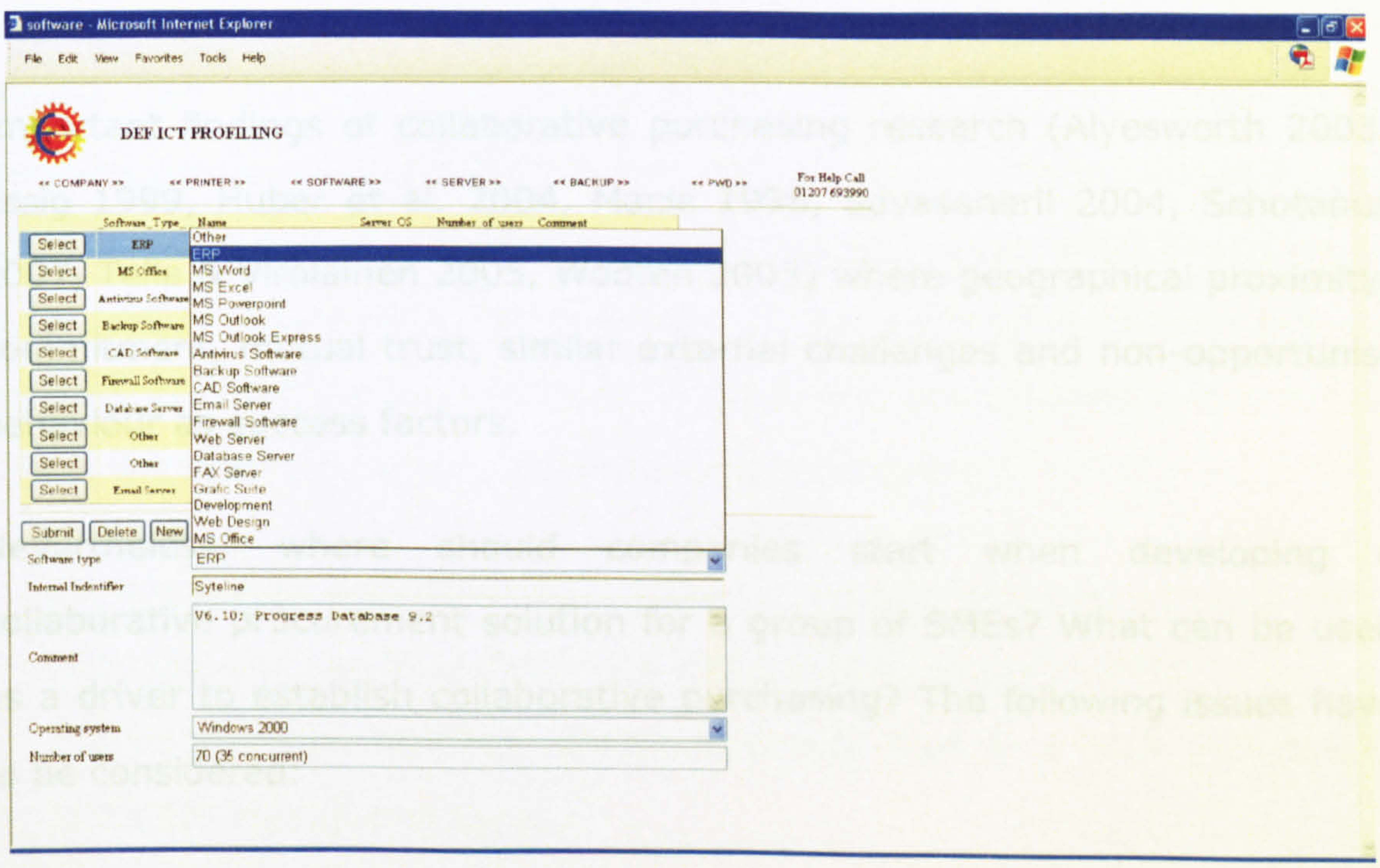


Figure 44: ICT profiling methodology – Software

Companies can login any time and maintain their information. From a procurement perspective, this survey was conducted bearing in mind a potential of buying volume licenses for generic but expensive software such as MS Windows Server 2003 or Veritas Backup Exec.

- Expensive collaborative procurement software or catalogue management solutions available on the market but realistically, there was no budget available to buy procurement software within this research project.

The ability to identify individual company demand was recognised as a crucial issue, as was the necessity for SME "islands" to communicate their needs. Therefore, a web based interface to announce and align purchase items must be developed. This will generate transactions (Starks 2003) and build acceptance of collaborative procurement solutions but sacrifice a solid consolidated product catalogue, which will be always under ongoing development.

The procurement process workflow is not complicated and basically consists of four steps: 'Plan-Source-Buy-Move'. Complexity within this research results from the fact that each partner organisation has demands for identical items, usually with different delivery requirements, suppliers and organisational procedures. An inter-organisation collaboration based on an IOIS complicates initially the operation of the purchasing process but the benefits gained from the utilisation of electronic procurement systems fully justify the need for change. Reasons for switching are:

- Complex and expensive ICT systems usually afforded to only large organisations can be utilised by a collaborating group of SMEs;
- The aggregation of single demands should lead to a 'bulk purchasing' effect for mutual purchases;
- Work time savings through electronic processes;
- Development of competence centres within participating companies for individual product groups.

From experiences gained during this research (see Chapter Seven) with the purchasing work of SMEs, it can be argued that there are framework agreements with preferred suppliers, but the actual purchase orders are project related. This project related, but also routine and transactional purchasing work should be conducted by a central purchasing department aggregating similar purchase items from different projects providing one interface to suppliers. The simplified inter-organisational procurement process is shown in Figure 45.

Each individual organisation (O1, O2 and O3) has a number of parallel running projects (P1, P2 and P3) with associated items to procure. Normally an ERP system will run a procurement schedule against the master production plan. Smaller companies create procurement schedules by hand or purchase on demand. From an inter-organisation perspective workflow depending on the number of participating organisations, multiple instances (I1, I2 and I3) of the aggregated purchasing processes, for example, for welding gases have to be scheduled. Within a hypothetical scenario:

- Organisation O1 is a manufacturer of "tables" with several customers (here indicated by different projects P1, P2 and P3);
- Organisation O2 is manufacturer of "shelves" working parallel on several orders;
- Organisation O3 is manufacturer of "workbenches".
- All organisations have to purchase, for example, tubes (B1), wood (B2), nuts and bolts (B3). For each organisation (O1, O2, O3) and each item to buy (B1, B2, B3) an instance of the purchasing workflow has to be invoked. The aggregated workflow instances are shown in Figure 45 with I1= all tubes B1; I2= all wood B2 and I3=all bolts B3. This constitutes the demand aggregation implemented into the collaborative software prototype.

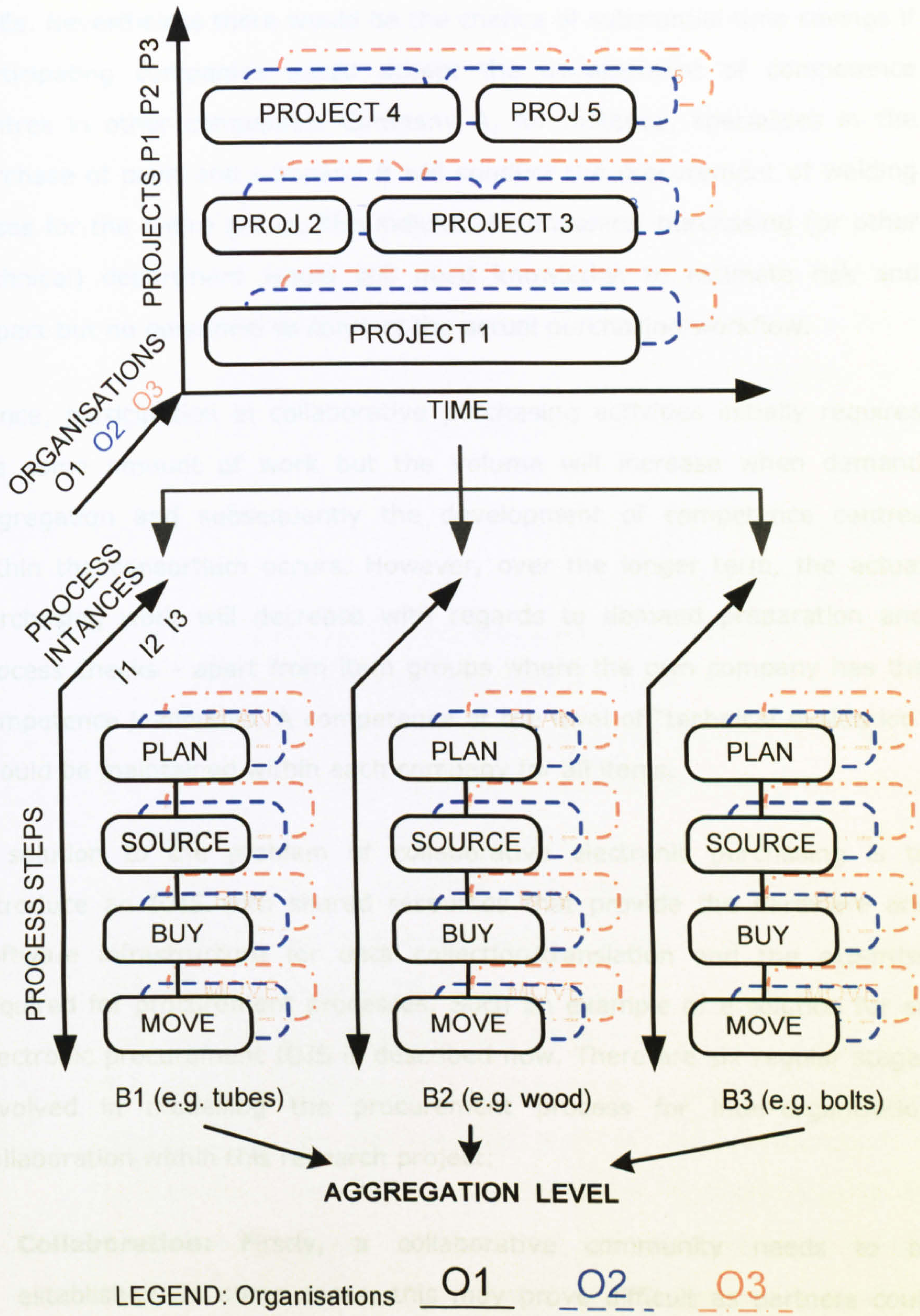


Figure 45: Inter-organisation procurement demand aggregation

Business processes, such as purchasing, are not outsourced by most of the SMEs. Nevertheless there would be the chance of substantial time savings if participating companies would accept the development of competence centres in other companies. Company A, for instance, specialises in the purchase of paint and company B will conduct the procurement of welding gases for the entire group. The individual companies' purchasing (or other technical) department would still need knowledge to estimate risk and impact but no personnel to conduct the actual purchasing workflow.

Hence, participation in collaborative purchasing activities initially requires the same amount of work but the volume will increase when demand aggregation and subsequently the development of competence centres within the consortium occurs. However, over the longer term, the actual purchasing work will decrease with regards to demand preparation and process checks - apart from item groups where the own company has the competence leadership. A competence at the level of "technical evaluation" should be maintained within each company for all items.

A solution to the problem of collaborative electronic purchasing is to introduce an IOIS with shared resources that provide the hardware and software infrastructure for data collection/translation and the expertise required for procurement processes. Such an example of a solution for an electronic procurement IOIS is described now. There are six regular stages involved in modelling the procurement process for inter-organisation collaboration within this research project:

1. **Collaboration:** Firstly, a collaborative community needs to be established. In some cases, this may prove difficult as partners could also be competitors and a certain level of suspicion inhibits full participation. To address this problem we need effective means of communication.
2. **Communication:** Telephone, facsimile, email, newsgroups and Web pages are the most common forms of communication but are not ideal

replacements for real world audibility. Regular meetings with partners are a pre-requisite to achieve successful communication. Genuine collaboration is a result of effective communication and trust, which tends to progress much through personal face-to-face interaction. Trust is not built at e-speed and this is true for any collaboration.

3. **Identification:** The communication process initially identifies items for collaboration, for example, identical products with different part numbers, descriptions and vendors. Product specification plays a major role in identification and aggregation of demand. A detailed item description is available either in the form of a supplier product catalogue or within a company's ERP system.
4. **Data Collection:** Information collated is stored in a database with a detailed description and unique part number. Data collection is limited to demand quantity at an agreed time and demand can be viewed as either regular or irregular. Database development will begin with the key items that are common to the organisations participating in the collaboration.
    - *Irregular demand* fulfils through incentive alignment of key items: To encourage and promote collaboration the identification of a short-term gain or incentive was viewed as essential. The purchase of utilities provided quick but significant cost savings (see Chapter Seven), which was necessary to maintain a high level of interest. Although the mentioned utility (in this case electricity) purchasing initiative proved to be advantageous it was identified as an intermediate step in the development of collaboration, but did not fully close the electronic loop of the procurement process. The exercise allowed participants to gain firsthand experience of the process and the approach assisting in the incidental build-up of a mutual database.
    - *Regular demand* fulfils through bulk purchasing: Regular supply can be accomplished by collaborative partners submitting monthly (recurring) demands to the collaboration hub.

5. **Aggregation:** The Outcome of the collated data will be aggregated and prepared for the collaborative procurement process. Co-ordination becomes increasingly difficult with the rising number of organisations and number of procurement process instances that have to be aggregated, for example, standardisation of slightly different items such as cutting fluids supplied through different manufacturers. The communication process is considered a key factor for successful collaboration. Aggregation of demand is only possible if effective communication processes and agreement can be achieved. The utilisation of numbers generates leverage within the bulk purchasing process resulting in cost and time reductions.
6. **System Integration:** To achieve inter-organisational collaboration beyond the level of operational procurement a collaborative supply chain management system with aggregation, process automation and an in-depth information sharing process is required. For instance, the processes can be further automated and integrated with the introduction of a collaborative forecast demand system. The deployment of such a facility is beyond the scope of this research.

6.3 REALISATION OF A WEB-BASED COLLABORATIVE PROCUREMENT PROTOTYPE SOFTWARE

Success stories of collaboration in purchasing are rare (Anand & Ravi 2003, Kauffman & Wang 2001, Nollet & Beaulieu 2005); hence, purpose of this project is to research a new approach for a horizontal group of SMEs forming a consortium. To explain the mode of operation of the collaborative prototype software the high-level logical structure is elaborated first, followed by a detailed example of the actual realisation and implementation of the purchasing function. Finally, details of the programmatically database structure are described.

6.3.1 Logical structure

Procurement for a collaborating group of SMEs should be driven by current or forecasted demand. In such a scenario, it is imperative to simplify the software as much as possible. However, the purchasing process comprises at least the steps planning, sourcing, decision making - buying, delivery (move), invoice and potentially return. The demands are assigned to procurement tasks, which pass through several stages during their task-lifecycle as described below.

Figure 46 summarises the proposed prototype software. The following stages were considered necessary for modelling the workflow within this collaborative electronic procurement prototype software:

1. **SCHEDULE:** Purchases are planned with no fixed date – This stage is viewed (and is only visible to collaborating partners when option "collaboration" is chosen) for the preparation of purchases.
2. **SUBMIT:** Demand, quantity and required delivery date – An item of this status is ready to be purchased with or without utilising collaboration.
3. **RFQ:** Open negotiating process – Each supplier can view requests for quotation and related items.
4. **OFFER:** Receive a quotation – Offers are made available (usually more than one), notification of quotation is sent to all participants. Partners have to accept the quotation or trigger the stage of the RFQ again to re-negotiate.

5. **ORDER:** Submit an order – A supplier has to confirm the acceptance of the order.
6. **DELIVERY:** to collaborating companies individually.
7. **INVOICE:** to collaborating companies individually.
8. **PAYED:** Payment received – The task is closed and the information archived and available for repeat orders. Direct links to financial transaction systems have not yet been considered.

To submit demands to the web based purchasing hub new purchase items can be created within the owning company's database. Existing items can be selected from the databases of participating suppliers or standard consortium hub items. The announcement of demands for collaboration is the entrance for this proposed collaborative procurement hub. Items marked for collaboration will be slightly different and it is the responsibility of the procurement personnel to reach an agreement – the proposed software will support the addition and removal of individual company's demands. After reaching an agreement, the delivery process for each individual company can be arranged. Finally, open invoices are displayed but no link with payment systems is considered within this software prototype.

First step of interactions with the prototype system is a user authentication, which is characterised by username, company name and password. Related with the company name is the status of a buyer or supplier. Companies participating in both cases have two login company names.

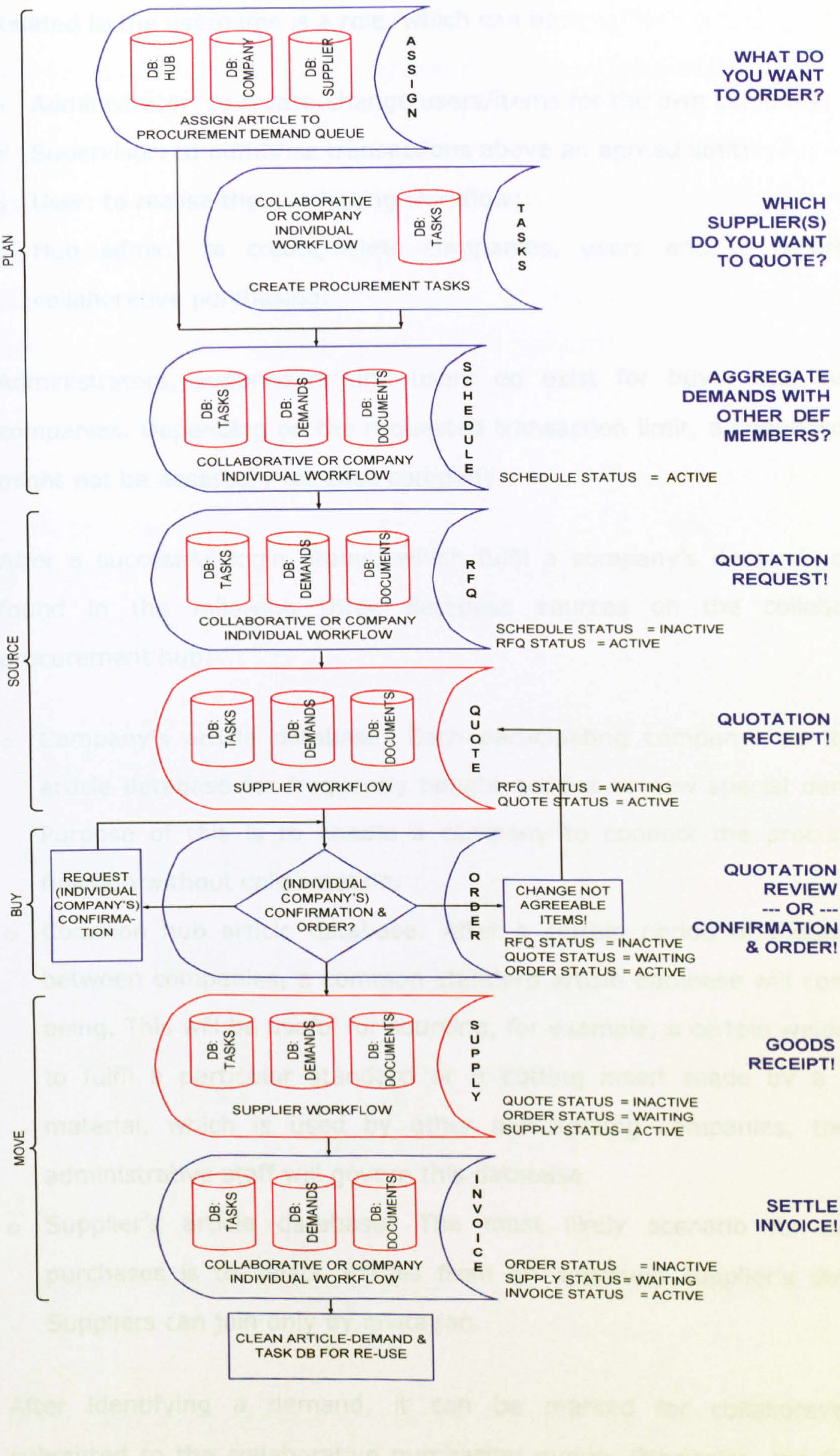


Figure 46: Procurement workflow adopted in the pilot software

Related to the username is a role, which can be:

- Administrator: to create/change users/items for the own company;
- Supervisor: to authorise transactions above an agreed limit;
- User: to realise the purchasing workflow;
- Hub admin: to create/delete companies, users and to co-ordinate collaborative purchasing.

Administrators, supervisors and users do exist for buyer and supplier companies. Depending on the requested transaction limit, a supervisor role might not necessary for each company.

After a successful login, items, which fulfil a company's demand, can be found in the following three database sources on the collaborative procurement hub:

- Company's article database: Each participating company has its own article database for frequently bought articles or new special demands. Purpose of this is to enable a company to conduct the procurement function without collaboration.
- Common hub article database: After a certain period of collaboration between companies, a common standard article database will come into being. This will be useful for sourcing, for example, a certain welding gas to fulfil a particular standard or a cutting insert made by a special material, which is used by other participating companies, too. Hub administrative staff will govern this database.
- Supplier's article database: The most likely scenario for common purchases is to select articles from an approved supplier's database. Suppliers can join only by invitation.

After identifying a demand, it can be marked for collaboration and submitted to the collaborative purchasing queue. Otherwise, the item can be found in the individual companies purchasing queue. Hereafter a purchasing task will be created and items assigned to this task. The purchasing process passes through several stages until completion.

Figure 47 shows the Procurement Data Triple, which was developed to visualise the process implemented into the collaborative procurement software prototype. Buyers and suppliers view the same Procurement Data Triple through their individual screens of the web client and different functionality will be enabled. The triplet consists of:

1. Demands such as physical items or services;
2. Related documents such as drawings or covering letters to describe further details;
3. Workflow statuses to specify the possible following activities and responsibilities.

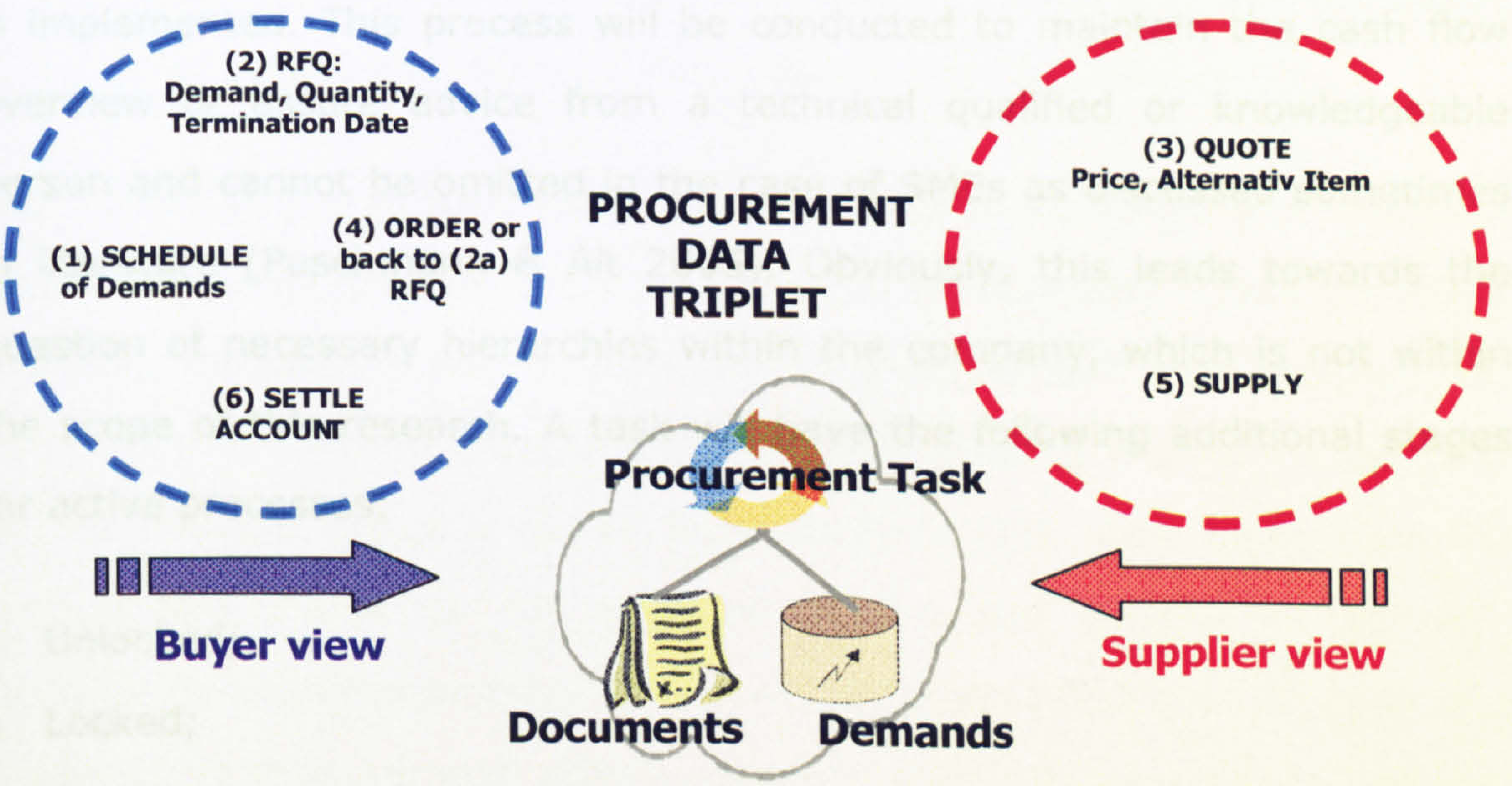


Figure 47: Procurement data triplet: tasks, items and documents

Each purchasing demand is passing through the procurement workflow stages with changes in demand parameters and related documents. For example, most important demand parameter, which is many times not exactly known at the beginning of the purchasing process, is the price information. Other parameters are delivery time or packaging quantities (see section 6.3.3). Furthermore, each status of a task has four possible stages, which are amplified by traffic light colours:

- Active (green);
- Waiting for reply (yellow);
- Locked (red);
- Hidden (after the completion of the task status).

An authorisation process is important for collaborative and internal processes. Authorisation within this prototype software solution will be initiated through a notification email and online confirmation or, if problems arise, a manual and individual problem solving process. At this moment, only if an activity exceeds an individual amount an authorisation procedure is implemented. This process will be conducted to maintain the cash flow overview or assure advice from a technical qualified or knowledgeable person and cannot be omitted in the case of SMEs as discussed sometimes in literature (Puschmann & Alt 2005). Obviously, this leads towards the question of necessary hierarchies within the company, which is not within the scope of this research. A task will have the following additional stages for active processes:

- Unlocked;
- Locked;
- Confirmed.

This authorisation is applicable for items and the entire detailed task as well. If tasks or attached items are locked, it cannot proceed and these items will not be considered within the following status.

6.3.2 Functional structure

To use the collaborative procurement software all users must be authenticated by a username, company name and password. Depending on the type of company (buyer, supplier or hub) and user role, different functionality will be available (Figure 48 top).

In this demand driven collaborative procurement environment two choices emerge:

1. Submit your own demands to the procurement queue by clicking the "demand button" and select an article from a database (Figure 48 bottom); a decision to publish this item for collaboration and subsequent demand aggregation should be made now;
2. Increase the demands submitted to the collaborative procurement queue by other participants by your own requirements (see Figure 54).

Next logical step is to start the purchasing workflow by creating an overview task. This can be done by every user of a buying company. Tasks are either individual company based or collaborative procurement. Subsequently, for each involved supplier a detail task has to be created (Figure 49 top). Per default the task status is set to SCHEDULE=ACTIVE. Now items from the procurement queue can be attached to the task (Figure 49 bottom). Quantity and desired delivery date have to be specified now. In case of a collaborative procurement activity, several identical demands of different companies are visible. During the SCHEDULE status, communication amongst participating companies takes place to agree on technical parameters, delivery dates, etc. In principal, every user can include purchase items of other companies at this stage but before sending out an RFQ a confirmation on item/task level by each participating company is imperative. The handling of collaborative tasks will be set up with a virtual company "hub".

To continue with the next purchasing step the status of the purchasing task must be changed to RFQ (Figure 50 top) for each involved supplier. The default status is RFQ=ACTIVE (green). After submitting the task will turn yellow on buyer side (RFQ=WAITING) and the activity will be visible to the supplier (QUOTE=GREEN) (Figure 53).

After a reply, the task will become inactive and disappear (RFQ=hidden, ORDER=ACTIVE) at the current level RFQ but appear at the next higher level ORDER waiting for further processing (Figure 51 top). Inactive tasks are not shown anymore but are still available for reactivation, for example, for repetitive use. A "waiting" RFQ task can still be resubmitted to a supplier. When submitting a quotation, this task on the supplier site will be set "waiting" until a buyer triggers the order. This may never happen because the buyer decides to purchase from another supplier or change the status of the task back to RFQ and re-negotiate (Figure 51 bottom).

The third stage inactive/locked (red) will occur when a user triggers an activity outside the authorisation level. In many cases, this will be a regular ordering procedure to request an authorisation for ordering (buyer) or quoting (supplier). Another option to apply the stage inactive/locked is when a supervisor decides to put an activity on hold.

Figure 51 shows returned quotations which are ready to ORDER or alternatively the workflow status can be downgraded to RFQ again and re-submitted to suppliers. At this point a new task for a supplier with the status SUPPLY is created (ORDER stage=waiting; QUOTE stage=inactive).

Figure 52 shows a locked ORDER waiting for approval and below a screenshot with the status INVOICE. Submitting the workflow status SUPPLY is synonymous with a delivery leaving the supplier's site and INVOICE is a notification of a completed financial transaction. Both are just informal at this stage.

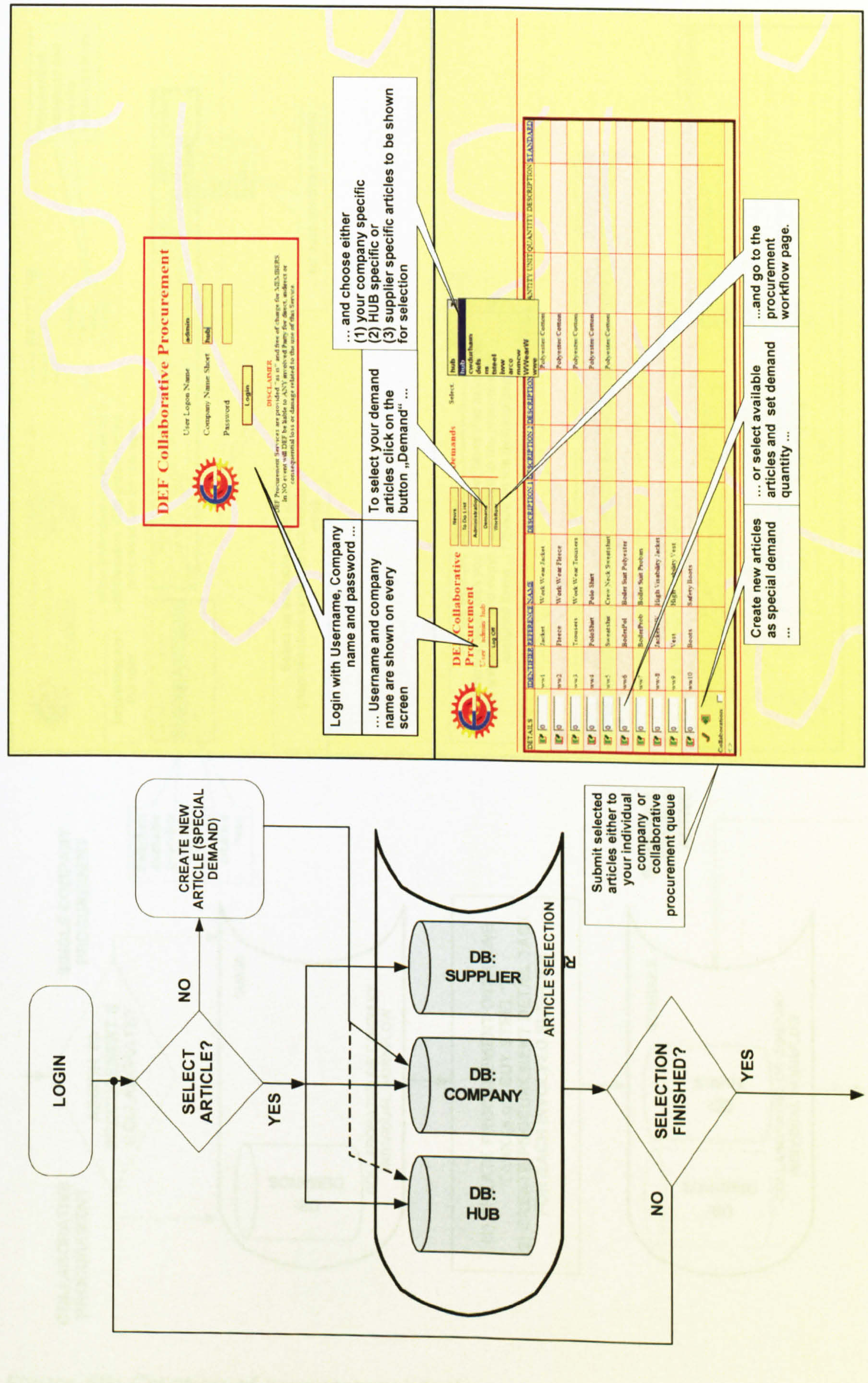


Figure 48: Item Selection Process

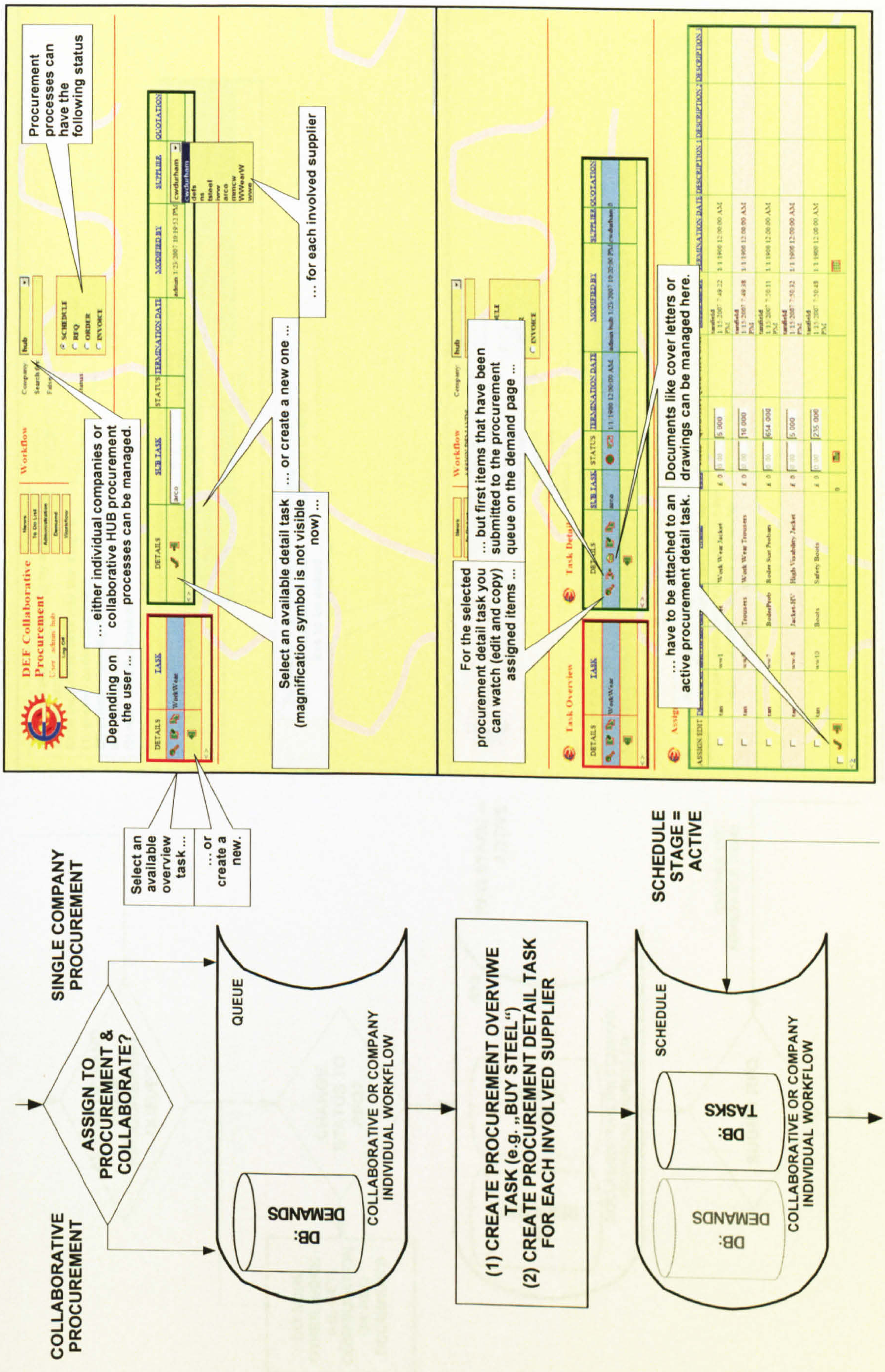


Figure 49: Creation of procurement tasks

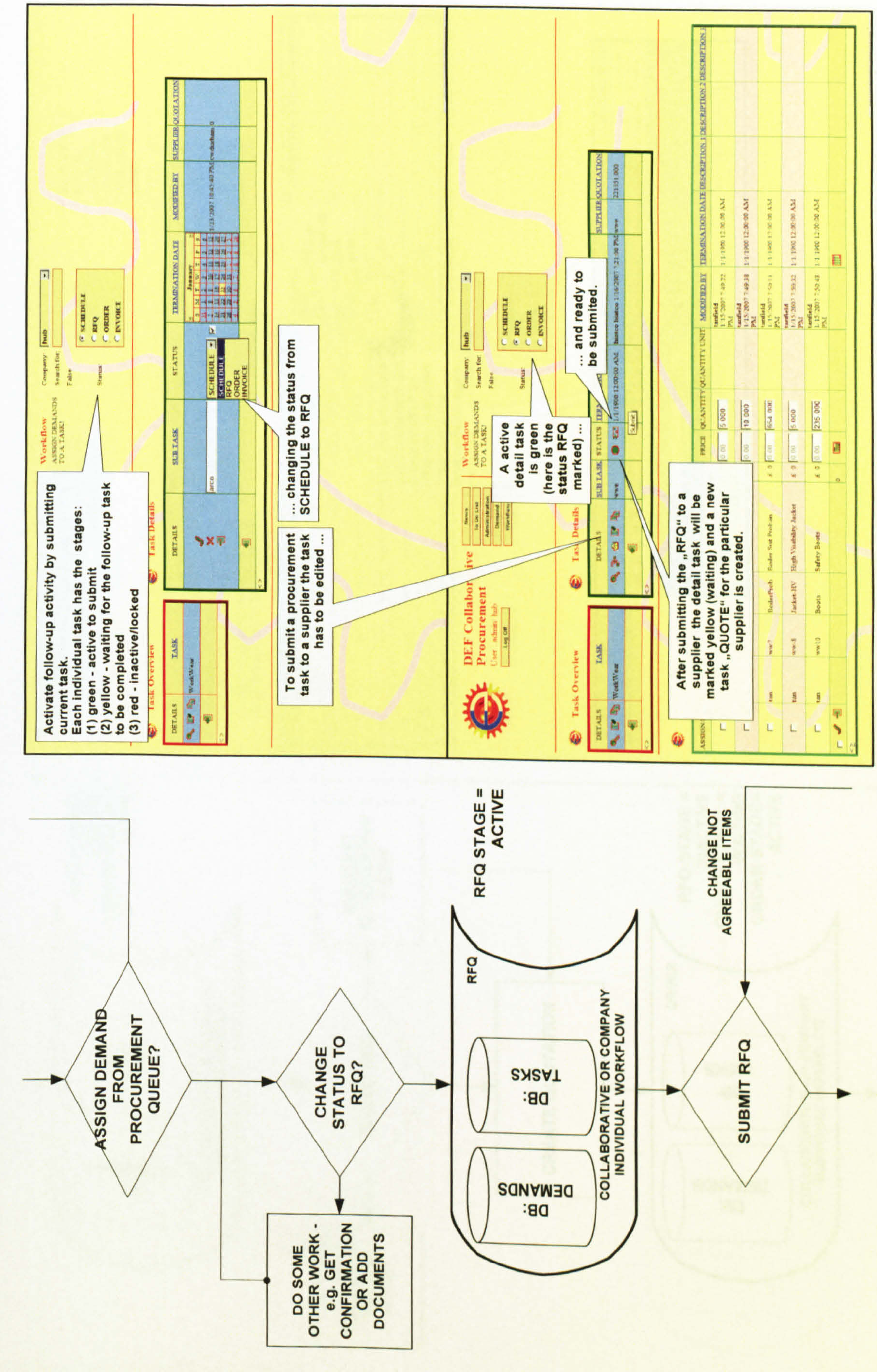


Figure 50: Submit Request for Quotation – RFQ

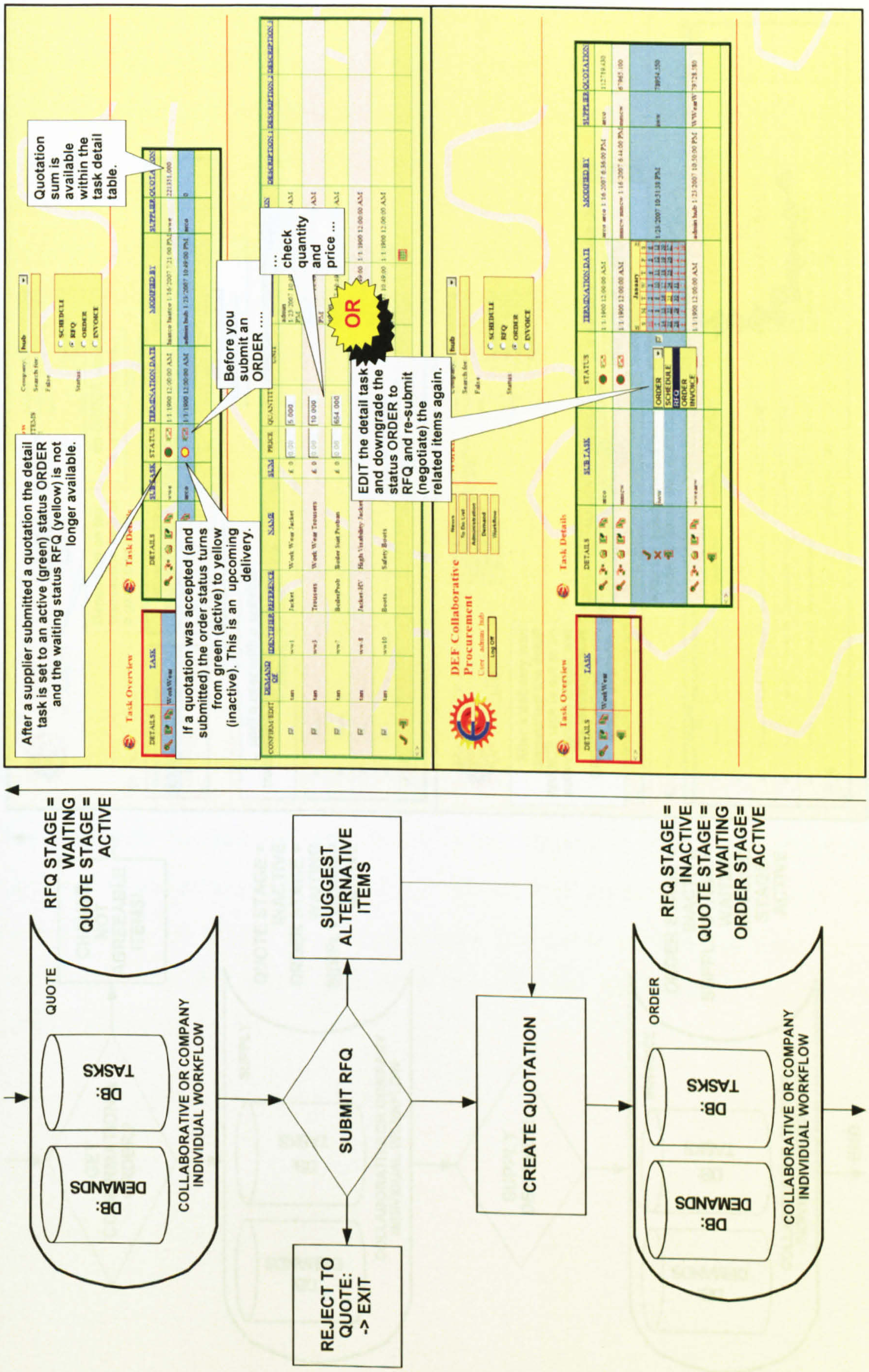


Figure 51: Change of the purchasing workflow status

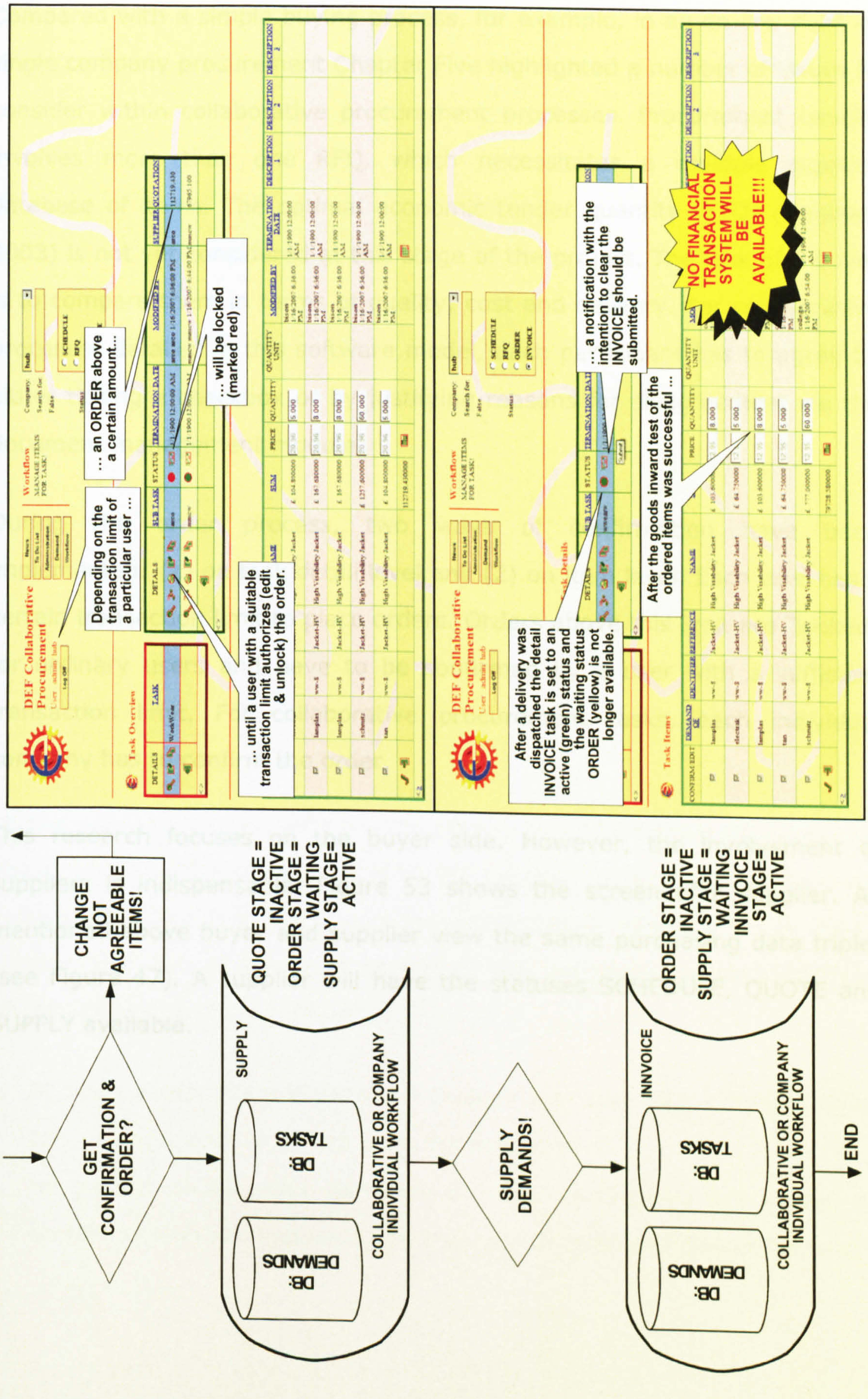


Figure 52: ORDER and INVOICE workflow statuses

Compared with a simple buying process, for example, in an on-line shop or single company procurement Chapter Five highlighted a number of issues to consider within collaborative procurement processes. Procurement usually involves more than one RFQ, which necessitates a multiple supplier database of items. The optimal economic tender quantity (ETQ) (Heijboer 2003) is not yet considered at this stage of the project. The task of a buyer is to compare them in terms of quality, cost and delivery. For collaborative processes detailed in this software model, each participant has to agree by either ticking a checkbox or by justifying reasons for disagreement via the document management module.

During the order process, two ways of confirmation have been implemented: (1) on task detail level and (2) on item level. Each user has a certain transaction limit to place orders. Orders above this limit are "locked" for ordinary users and have to be confirmed by a user with a sufficient transaction limit. For collaborative procurement tasks, each individual company has to confirm the order.

This research focuses on the buyer side. However, the involvement of suppliers is indispensable. Figure 53 shows the screen of a supplier. As mentioned above buyer and supplier view the same purchasing data triplet (see Figure 47). A supplier will have the statuses SCHEDULE, QUOTE and SUPPLY available.

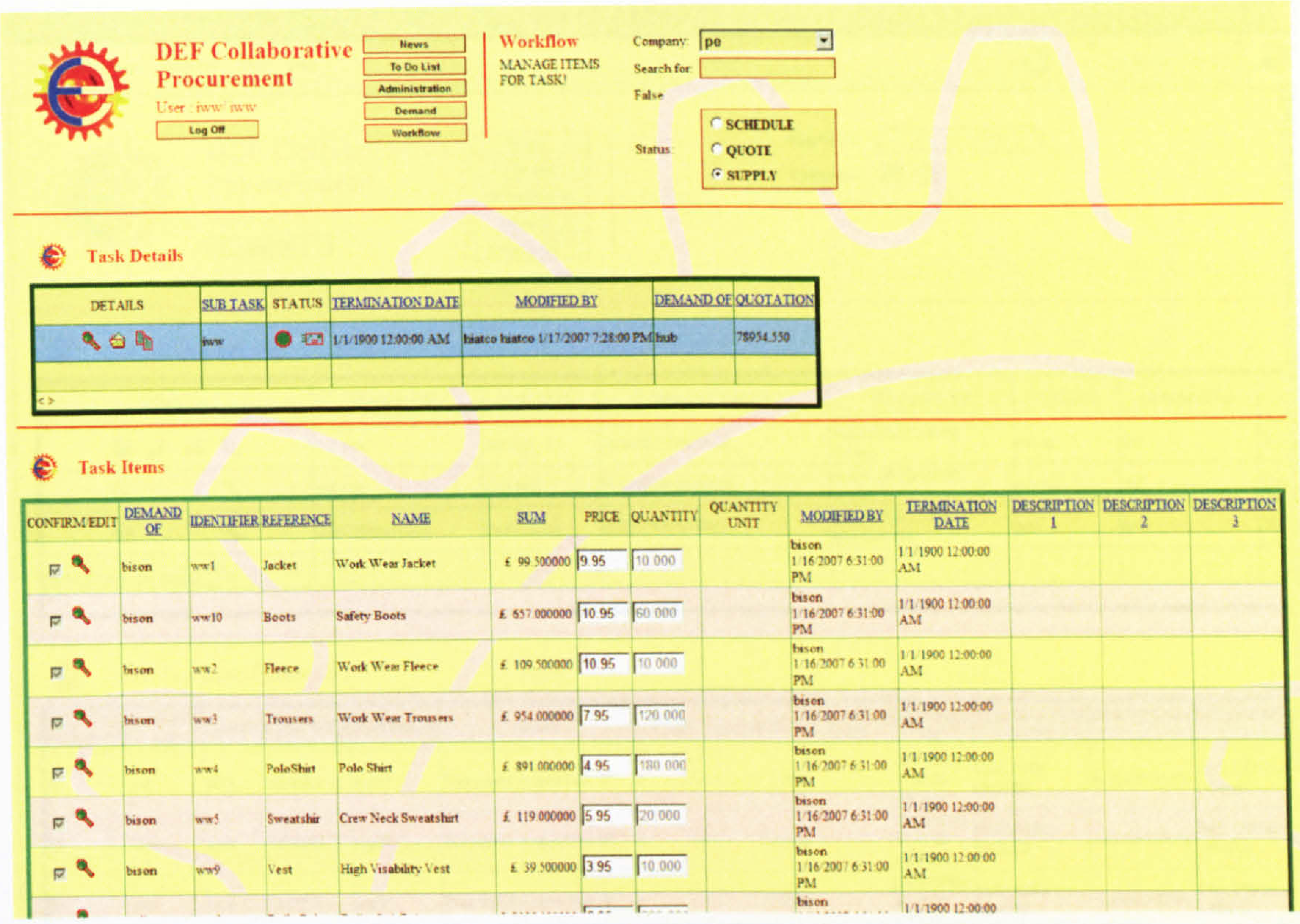


Figure 53: Supplier view

In the scenario of the software prototype, all collaborative demands are visible to all participating users with the purpose of stimulating a demand aggregation. The fast track workflow confirmation panel is shown below (Figure 54). This is the start screen of the prototype software and two important functions are offered:

- All open quotations are shown. A (supervisor) user with sufficient rights can lock or authorise orders from the first screen.
- All current collaborative demands of other participants are visible. All current individual company's demands are beneath the button Demand.

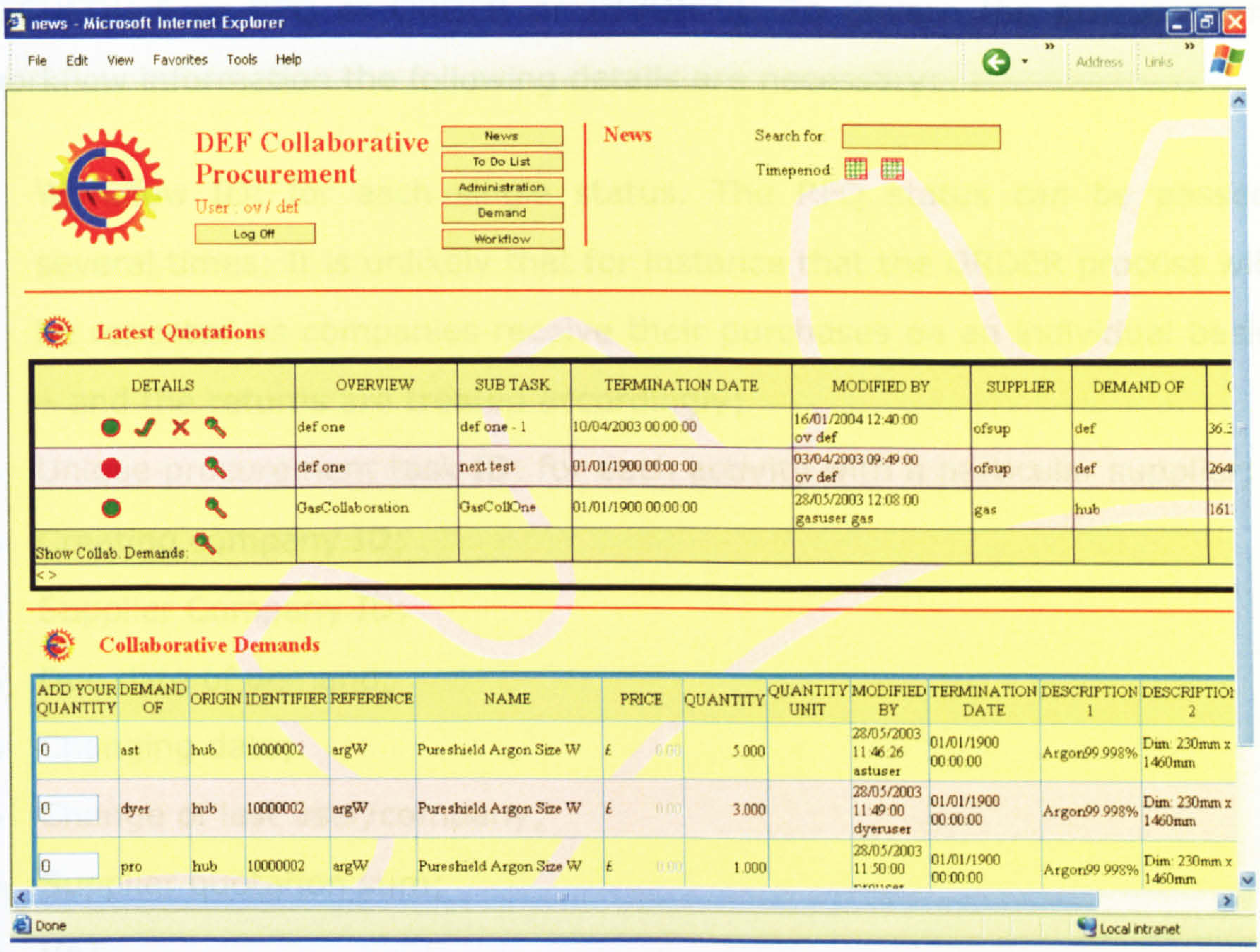


Figure 54: Fast tracking and collaboration

6.3.3 Software structure

The software structure of the collaborative procurement pilot is derived from the Procurement Data Triplet (see Figure 47) consisting of tables representing workflow, item and document information. These three tables will be generated for each participating party. Other tables, for instance a user table will be generated only once (see Appendix D).

1. Workflow:

A procurement workflow is realised in form of a data table holding all fields described below as columns. Basic idea is to filter this workflow "queue" table in a way that for a user only the desired status remains visible

(SCHEDULE or RFQ or ORDER or INVOICE). To govern the procurement workflow information the following details are necessary:

- Workflow ID: for each single status. The RFQ status can be passed several times; It is unlikely that for instance that the ORDER process will be repeated as companies receive their purchases on an individual basis - and the returns are treated accordingly;
- Unique procurement task ID: for each activity with a particular supplier;
- Creating company ID;
- Supplier Company ID;
- Due date of demand;
- Changing date;
- Change of last user/company;
- Supplier quotation sum;
- VAT;
- Total postage and package (Overview list within documents);
- Task stage (active, waiting, inactive/hidden);
- Authorisation stage (unlocked, locked, authorised).

2. Documents:

A collaborative procurement solution can be utilised not only for the purchase of standard items, but also for customised special demands. Therefore, it is necessary to have opportunities to attach necessary documents and to write covering letters as well. This is achieved through the document management module.

3. Items:

The third part of a procurement dataset is information about the item itself. Each item has a unique identifier. It is very likely that a supplier will offer a slightly different item than requested. Another possibility is a varying quantity scenario during the negotiating process. Important properties for procurement items focuses especially on collaboration are the following:

- Item ID;
- Workflow ID: for each single item;
- Unique item ID;
- Due date for the item;
- Change date of the item;
- Change user/company ID of the item;
- Origin company ID;
- Origin company order reference;
- Origin supplier ID;
- Item quantity;
- Item quantity unit;
- Price per quantity unit;
- Authorisation stage (unlocked, locked, authorised).

6.4 SUMMARY OF THE CHAPTER

How can a group of SMEs realise a collaborative electronic purchasing process?

When developing collaboration in the field of purchasing it is necessary to (a) collect individual companies' demands and (b) provide this information to other members. The logical consequence is the development of demand capture and aggregation software elaborated in Chapter Five. However, before this can be achieved as Chapter Four examines, the purchasing workflows, policies and cultures of individual members have to fit with a collaborative purchasing approach.

A single purchasing process itself is from an academic perspective not very complicated, and can be summarised as consisting of the steps Plan-Source-Buy-Move. Complexity arises from time and financial constraints when dealing with real life situations, diverting opinions on technical parameters and multiple process instances. A large number of active partners complicate a collaborative workflow process, too.

Within this developed and deployed collaborative purchasing prototype software, a new concept of the Procurement Data Triplet (Figure 47) is introduced to realise the process. Demand items (1) can be selected from three databases (suppliers, hub and individual company's database) or a special line item is created on demand. Parallel with actual demands, documents (2) can be added and both are attached to a procurement task (3). Within this software prototype, the procurement task passes through the stages SCHEDULE-RFQ-QUOTE-ORDER-SUPPLY-SETTLE ACCOUNT.

Depending on the user information, provided when logging into the system, different functionality will be visible or enabled and activities are logged by the system. For the purpose of collaboration in purchasing simply one additional Yes/No parameter is added to demand items when submitting to the purchasing queue. Collaborative demands are bought for the virtual company "HUB"; a confirmation per item or activity level is necessary.

A procurement solution that targets the general procurement process of a group of independent horizontal companies has to govern a potentially huge number of purchased items. Considering changes in price, availability or item replacements, a multi supplier/buyer database can only be developed during the ongoing research.

Critical success factors are strong senior management support, mutual trust amongst participants and critical mass of aggregated demands to reach a high supplier interest. Aggregation and identification of individual company's data proved to be a major issue within the collaboration model of this research. Other barriers for an implementation of collaborative purchasing can be seen as predominately human based and, (hidden) inter and inner-organisational objectives. In particular, the progress of the development of local competence centres needs regular involvement of the top management.

Due to limited resources, as only the author worked over a period of 18 month on the development of this prototype software, many desired features could not be implemented, namely search functionality, copy tasks, item categories, catalogue import/export to just name a few. The following problems related with horizontal collaboration (Kamann 2003) have to be addressed in the future:

- Partners have different (incompatible) internal processes (and ICT systems implementing those processes);
- Investigations into occurring costs when switching a supplier (Heijboer 2003);
- Intangible reluctance to change suppliers even though products are identical;
- Different culture of supplier management;
- Different strategic importance of one product;
- Management of a variety of different catalogues and automated update processes;
- Item categories across different catalogues.

From the perspective of a consortium, very important considerations relate to the necessary broad technical expertise when purchasing a vast variety of items and time commitment to conduct the purchasing workflow; even using electronic procurement the time commitment communicating with suppliers is enormous. An intermediate consortium can develop such resources only when charging a fee, which is obviously contrary to the objectives of participants in the first place. Anyway, a consortium does usually not possess the technical expertise to evaluate all items – it is not the own purchasing. Here commitment and participation of members is imperative. Still, the member companies of the consortium need to conduct the purchasing workflow.

7. RESEARCH EVALUATION & DEPLOYMENT OF A COLLABORATIVE NETWORK

The previous chapters relate to the purchasing framework and context of collaborative purchasing consortia in general. This chapter describes as an example the work with the Derwentside Engineering Forum during this research project. General ideas on how to develop SME collaboration are described and detailed examples of actual collaboration are given. In addition, this chapter includes the specifics of several initiatives leading to the development of the collaborative purchasing prototype software. Experiences are summarised into a generic development model for SME consortia towards electronic collaboration. Appendix A gives a detailed overview of DEF activities, member companies and their core business.

7.1 APPROACHING COLLABORATING SMEs METHODICALLY

Collaboration aims to overcome individual companies' weaknesses by combining complementary skills and resources. The introduction of an intermediary consortium with a diverse range of involvement and services will give a good example of a collaborative network, especially considering limited resources within single SMEs. SMEs usually operate locally or in niche markets focusing their priorities on the creation of new business and delivery of current contracts. Combined with limited resources in small and medium companies this value chain focus exposes the other surrounding business areas.

These "other" business areas are the main concern of consortium-led business activities. In other words, the focus of the work with member companies is to support the peripheral business activities, which are in turn the motivation of member companies to participate. The delivery of a very diverse range of services is necessary to maintain a high level of interest and subsequently develop mutual trust. Beside these "peripheral" services, DEF has recently expanded business activities towards the marketing of "Integrated Engineering Services" to deliver turnkey solutions to customers. This is a step towards integration into member companies core businesses and crucial for financial sustainability of a consortium.

Within this research, the approach to establish collaboration included the following methods:

- **Gain knowledge:** Semi structured interviews and conversations are necessary to translate perceived problems into structured workable approaches.
- **Network knowledge:** Identify companies with similar problems and communicate them. Only when "aggregating" similar problems, the facilitation of resources becomes economically viable (see Figure 4).
- **Short-term delivery:** Many times, the current problem is considered as 'the' most important. Success in delivering assistance in areas such as credit checks or broker emergency capacity maintains the commitment and attention level of members (see 7.2). The benefit to the business goals of the consortium is limited.
- **Medium-term delivery:** of collaborative projects, need a change of the approach of participating companies. Facilitation of collaboration in areas such as purchasing, business continuation management, product

development (see 7.2) generates a significant increased perception of the importance of an intermediary organisation.

- **Long-term delivery:** creates the service "collaboration" as a product. Here, competitors cannot replicate an intermediary hub. Trust amongst participants of different hierarchical levels, access to and knowledge of information systems or knowledge of usually hidden internals are essentials for successful collaboration amongst SMEs. One example is the sale of the concept of "Integrated Engineering Services" to customers such as MOD or railway enterprises; secondly, the concept of DEF was franchised within County Durham (UK) recently by establishing Sedgefield Engineering Forum and East Durham Engineering Forum.

7.2 Introduction to DEF

The purpose of the following description is to give a picture of the complexity of a collaborative network. Many tasks within the research project duration were directly related to the main objective: to research the deployment of a consortium supporting collaborative electronic purchasing for SMEs. An equal amount of work was supporting other initiatives, which was necessary to meet the objectives building mutual trust and delivering immediate benefits.

Derwentside Engineering Forum (DEF) is a non-profit organisation established in autumn 1999 by a group of private sector companies to develop the engineering and manufacturing capacity of the Derwentside area. The 30 companies of DEF with a turnover in excess of £150m employing about 3500 people constitute a significant part of Derwentside's local economy. The Forum funds its operations through member subscription and public financial support, which is the majority of the income now. Contributors are the local councils (Derwentside and Durham), ERDF (European Regional Development Fund), SRB (Single Regeneration Budget), Business Link and other temporary changing sources related to economic development projects in the public sector.

The first objective was to address the skills shortage in engineering especially concerning young apprentices. The founders of the forum considered that the number and "quality" of pupils entering engineering as a career was too low. To increase the number of students taking an engineering course at the local college and the general educational level the concept of "Schools Engineering Challenge" was developed. All local secondary schools in Derwentside compete against each other in teams who conduct tasks like building a model car, design and test bridges or generate energy with a self-made "wind-turbine". Employees of member companies mentor the work at the school during about 10 afternoon sessions.

The second objective of the Forum is to address mutual problems. This group of activities is usually short-term related to deliver immediate benefits, specifically the support of buying electricity or a collaborative subscription, for example, British Standards Online or Croner Consultancy Services. Such activities are considered from an individual company perspective as "disposable" (Arnold 2000), but deliver substantial benefit by collaborating within the consortium. Most of the activities of DEF can be categorised as "value adding" but are not directly involved into the daily core business.

Hence, the third and most difficult area of activities target the involvement into the core business of Forum member companies, namely initiatives like "Integrated Engineering Services", product development support or collaborative purchasing. Particularly important is an understanding of the general business strategy of the Forum and individual member companies needed to be aware of possible commitment and involvement during this research.

All services and initiatives were developed during this research project – demanding a significant time commitment. An in-depth introduction into the activities of the Derwentside Engineering Forum is given as follows:

1. Industry Education Partnership:
    - Schools Engineering Roadshow;
    - Schools Engineering Challenge;
    - Neighbourhood Engineers;
2. Business Support:
    - New Product and Process Development;
    - Consultancy and Training;
    - Employment, Health and Safety Advice;
3. Collaborative Working:
    - Integrated Engineering Services;
    - Sales and Marketing;
    - Bulk Purchasing;
    - Business Continuation Management.

There are many organisations - limited by guarantee or non-profit making – intermediaries or consortia, that aim to facilitate collaboration, support and service member companies in areas surrounding their core business. The most important success criteria for an intermediary organisation are reliability of deliveries based on member requests, which is the core business of the intermediary itself. DEF engage in a broad field of activities, and as such, the author carried out many tasks which were not directly related to the core theme of the research. While this obviously had negative time implications, it also ensured the participation of DEF members in the main study.

7.3 Collaborative Purchasing in the Context of DEF

Aiming at the development of a collaborative electronic purchasing consortium, the initiatives described in this chapter lead to the development of the collaborative purchasing software prototype described in Chapter Six. To investigate the actual purchasing process and items, the project started with a generic semi structured interview of purchasing staff within the involved companies. The interview process enabled the participating organisations to get to know each other, especially across different companies and to develop mutual trust, followed by an initial trial into the collaborative purchase of electricity and office stationery and subsequently moving into more complex areas as welding gas or MRO (Maintenance, Repair and Operations) supply. Finally, an ICT survey was conducted to obtain knowledge about the information systems infrastructure as a foundation for the development of the collaborative purchasing software prototype.

7.3.1 Observations on commodity purchasing

The collaborative purchasing initiative of DEF was introduced to member companies within a regular monthly forum meeting at managing director level. Previously only the steering group was involved when designing the research and conducting interviews. This contributes towards the objectives "Business Networking" and "Short-term Benefits" of this research.

The interviews where designed to explore the companies' potential interest to participate in this initiative. Managing director or senior purchasing staff of the companies conducted a guided tour through the premises and participated in a semi-structured interview. The focus was to investigate the 'magnitude' of the expenditure in non-direct materials. Indirect effect was the positive development of working relations.

During the interview the categories production, office, service, freight, work wear, and waste were given; the most important items for participants were captured. As expected, companies were using different suppliers (Table 11). Diverse areas of potential interest to participate in collaborative purchasing initiatives were suggested.

Category	Description (Employees)	Derwentside College (300)	Hiatco (24)	KC Eng. (38)	Multi-Arc UK (IonBond) (40):	NWC Precision (40)	Protocol Eng.(8)	DW Eng. (16)
Freight	Freight (Parcel)			1000 (MSAS, (Fright Agency))				
Freight	Packaging Materials			500 (Blaydon Packaging, M. Glas Packaging)	600 (Croder Chemicals, LS Yorks, Colton Packaging)	30000 (BD Case, Arco)		
Freight	Parcel Carrier		2000 (Neightfright, Lescost, Geologistics)	? (Tuffnells)	37000 (ANC, Interunk)	2500 (Night Fright)		
Office	Computer Consumables	30000			2000 (Various Anchor)			
Office	Hand Cleaner			500 (Arrow Chemicals)				
Office	Marketing Requirements	60000						
Office	Office Paper (Letter, Invoices)							? (Consett Printing Company)
Office	Office Supplies		1500 (United Office, Knights Office)		12000 (Anchor Supplies, Andrew Douglas)	700 (Staples Catalogue, Mannerform)	200 (Cromwell tools, SAGE, Minolta)	
Office	Office, Printing, Stationery	50000						
Office	Office, Printing, Stationery			600 (Viking Direct)				
Office	Toilet Rolls						153 (SMS)	
Production	Air Products				35000 (Air Products)			

Category	Description (Employees)	Derwentside College (300)	Hiatco (24)	KC Eng. (38)	Multi-Arc UK (IonBond) (40):	NWC Precision (40)	Protocol Eng.(8)	DW Eng. (16)
Production	Aluminium		150000					
Production	Cutting Oils and Fluids					1500 (Spartam)		
Production	Cutting Tips						1420 (Cromwell)	2500 (Glendower Cutting Tools)
Production	Degreaser						13 (SMS)	
Production	Fastener						200 (Team Valley Fasteners)	2000 (Bescol)
Production	Fastener (Screw, Bolt)		5000 (Fasteners Direct, Blyta, Arndace)	1000 (Thomas Potter, Hydrobolt)		20000 (Thomas Potter)		
Production	Ferrous Materials						10000 (Corus, Hillfoot)	
Production	Fuel				33000 (PHH Allstar)			8000 (Fina Card)
Production	Heating Oil						300 (GB Fuel)	
Production	Hydraulic Oil					10000 (GB Lubricants)		
Production	Hydrogen Peroxide				15000 (Brentag)			
Production	Lubricants					1000 (GB Lubricants)		
Production	Machine Maintenance Oil						250 (Milacron)	
Production	Oil, Tapping Paste, Cutting Fluid							1500 (Cromwell Tools)

Category	Description (Employees)	Derwentside College (300)	Hiatco (24)	KC Eng. (38)	Multi-Arc UK (IonBond) (40):	NWC Precision (40)	Protocol Eng.(8)	DW Eng. (16)
Production	Oils							1200 (Brown Bros)
Production	Small Tools					6000 (SECO)		
Production	Steel		20000					
Production	Taps + Drills					4200 (Cromwell Tools)		
Production	Target Materials				30000 (Titanium International)			
Production	Tools, Sprays		8500 (Cromwell tools)	30000 (Cromwells)				
Production	Vacuum Oil				2000 (GBR)			
Production	Welding Boots			? (Cromwells)				
Production	Welding Equipment		120 (Panda, Weldmore, New-Arc)					4000 (Weldmore)
Production	Welding Gas		10000 (Boc)	? (Air Products, Speedyhire)		2500 (D.J. Toolhire)	100 (Thomas Proctor)	1800 (BOC, B. Gas)
Service	Accountancy	20000 (Deloirre Touch)	? (K. Sharkey)	? (Straughans)		5000 (Haines Wates)	900 (Pullan Barnes)	1400 (Murray and Lamb)
Service	Cleaning	100000						
Service	Electricity		4200 (Norman Electric)		50000 (Northern Electric)	120000 (Independent Energy)	1400 (Yorkshire)	2200 (Independent Energy)
Service	IT Service				15000 (Keyanon)			

Category	Description (Employees)	Derwentside College (300)	Hiatco (24)	KC Eng. (38)	Multi-Arc UK (IonBond) (40):	NWC Precision (40)	Protocol Eng.(8)	DW Eng. (16)
Service	Landscaping				400 (Landlord's Contractor)			
Service	Maintenance of Vacuum Pumps				13000 (CPR Vacuum)			
Service	Marketing, Press, Magazines				25000 (Raven Marketing)			
Service	Mats + Toilets Cleaning				1500 (PHS)			
Service	Printing Leaflets						600 (Patterson Bros)	
Service	Security			? (ADT)	1800 (ADT)	350 (ADT)		? (ADT)
Service	Telecom	70000						
Service	Telecom / Data				12000 (Hathaway Associates)			
Service	Travel				26000 (Norssman)	3000 (Business Travel)		
Service	Utilities (Gas + Electric)	84000						
Waste	Waste		240 (Biffa)	? (Jennings)	2700 (Premier, Cleanaway)	500 (BIFFA)		
Work Wear	Boots, Goggles, Overalls				3000 (Arco)			
Work Wear	Gloves			? (Arco)				

Category	Description (Employees)	Derwentside College (300)	Hiatco (24)	KC Eng. (38)	Multi-Arc UK (IonBond) (40):	NWC Precision (40)	Protocol Eng.(8)	DW Eng. (16)
Work Wear	Gloves, Jackets, Boots						170 (SMS, Smallman Lubricants)	
Work Wear	Overall Cleaning			0,75 per item (Sunlight)				
Work Wear	Work Wear Cleaning		3000 (Johnson, Apparelmaster)		4000 (Apparelmaster)			1500 (Initial Textiles)
	MRO	20000						

Table 11: Summary of the general purchasing data

7.3.2 Electricity and office stationery trials

With the change of the millennium the monopoly of selling electricity was abolished. This provided an opportunity to purchase collaboratively in a liberalised market with real competition. The basic idea was to collect information about electricity consumption and negotiate based on the aggregated volume. Without having prior knowledge of the electricity market this turned out to be more complex than expected. The following problems were identified:

- **Commitment:** In good intention, companies represented by top-level management at DEF meetings agreed to provide information. This task was passed on to other employees for whom high priority work prevented them spending the necessary time to search for this information.
- **Contracts:** Several companies could not find their contracts and had to contact the current provider. Many did not know about price and actual duration until they actually looked at the current invoices or contracts.
- **Technicalities:** Companies with high production capacities have dedicated high voltage supply and backup capacity, which obviously complicates the purchasing process. Companies with more than one site had several suppliers.
- **Suppliers:** The end date of the contracts differed from company to company. This fact made it difficult to align all companies and negotiate with their combined buying power.

However, in the year 2000 the market prices fell due to the recently opened competition and significant success was made within this initiative. In this case, relatively small companies face a large supplier and the aggregated consumption was not accepted for offering a price accordingly. Instead, companies where given an individual quotation. However, comparing with current electricity contracts and usage (Figure 55) the savings that were made in the first year were exceeding £175.000 compared with old contracts. The fax-back forms that where sent out to companies are shown in Appendix B. During this first phase negotiations were conducted in conjunction with "The North-East Energy Initiative" (TNEI) and subsequently an agreement with BuyEnergyOnline.com was made dropping usual fees for DEF member companies. In the following years, most of the DEF member companies renewed their contracts through this link.

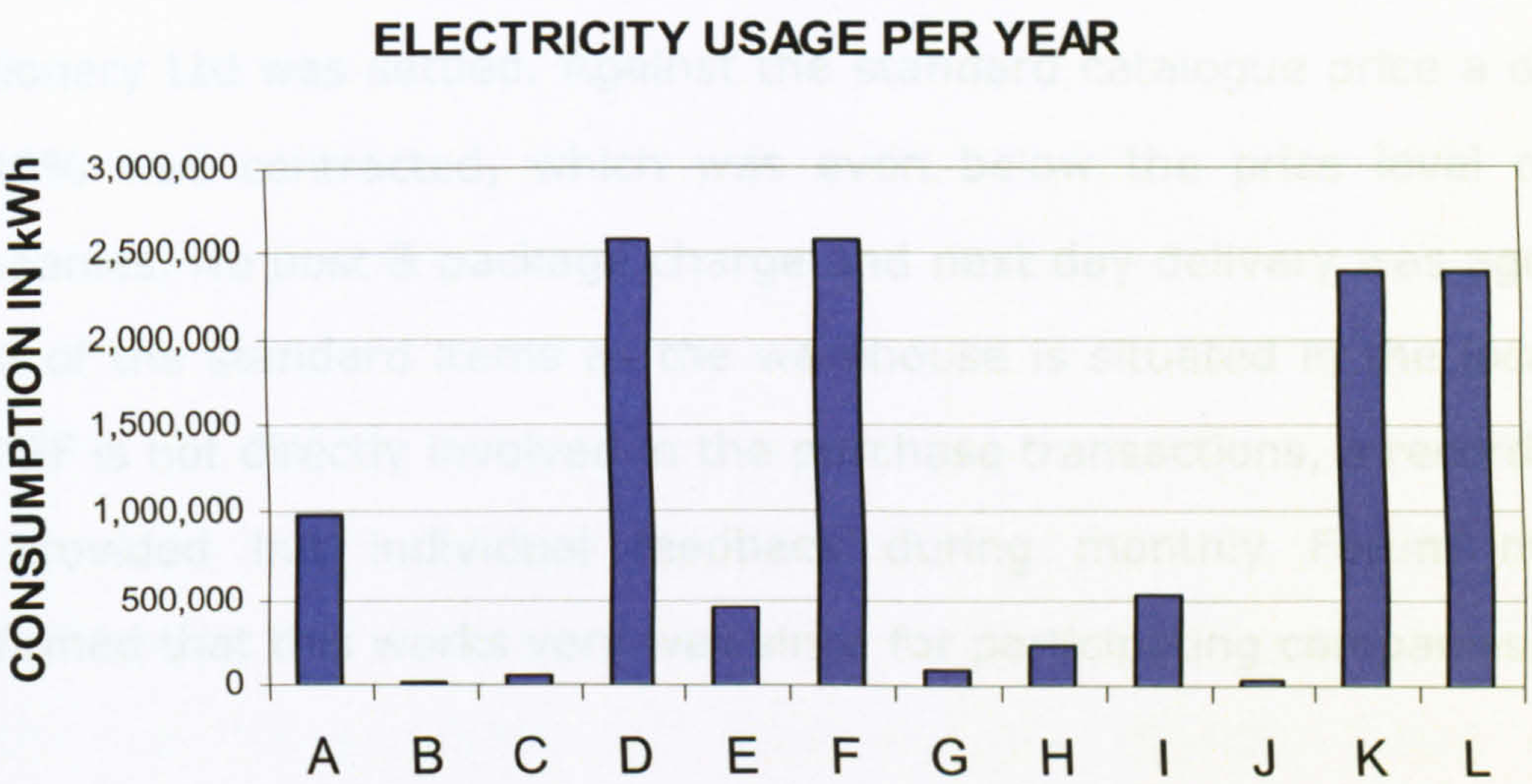


Figure 55: Electricity usage of companies (A to L) involved

Another promising area identified in the interview (see 7.3.1) to combine consumption of the group as leverage when negotiating with suppliers was office stationery. Again, suppliers hesitated and were reluctant to quote according to the overall volume. This is due to the fact that they have to deal with several individual companies, which is actually equivalent to several independent branches of a large organisation and the possibility that some companies might be their customer already.

One advantage of the Internet is the ability to easily compare prices for goods, and hence locate the best option. On the other hand, quality and delivery have to be considered and a change of a supplier involves a significant time investment, many times delayed delivery, new or different payment systems and business risk in general. Even if better prices can be achieved through demand aggregation, companies might still stay with the preferred supplier. Often a risk of changing the supplier is not taken as they may already have had bad experiences with that particular supplier before. Furthermore, the perception of a "high quality service" and related expectations will vary from company to company.

For the DEF consortium a contract with a company called Northern Stationery Ltd was settled. Against the standard catalogue price a discount of 40% was contracted, which was even below the price level of large companies. No post & package charge and next day delivery was agreed for most of the standard items as the warehouse is situated in the local area. As DEF is not directly involved in the purchase transactions, a record cannot be provided but individual feedback during monthly Forum meetings confirmed that this works very well since for participating companies.

7.3.3 Bulk purchasing trial with work wear

Another approach to collaborative purchasing was chosen when a member company with a large purchasing volume of work wear approached DEF. A form was sent to all other member companies to collect their additional demands. Companies returned the form containing their additional information and the aggregated group demand was sent to suppliers. In this case, a discussion concerning technical parameters was delayed until requests for quotations (RFQ) were returned from selected suppliers who were asked to provide different "quality" levels for each item and samples as well. An overview is provided in Table 12.

The process of communicating and aggregating the demands of individual companies took one month to complete. Much time was devoted to find the person the task was assigned, explaining the purpose of the demand aggregation activity and reminding to return the form. The list of aggregated demands (Table 12) was send to suppliers and returned with prices and delivery details.

The samples provided by potential suppliers were inspected during a regular monthly forum meeting. Subsequently, each individual company placed the order with the local supplier Industrial Work Wear Ltd, which was considered as the best offer. The facilitation through the Forum was very successful and again, interested companies purchase from a local supplier at a very competitive price, good quality, superior responsiveness and customer service. Feedback from member companies was very positive but from DEFs perspective the aim to develop a collaborative purchasing consortia can only be achieved by automating work like demand collection, RFQ, internal technical parameter discussion and order. It became clear that after initiating the contact, companies continued to work independently, which was not surprising but disallowed the possible future demand aggregation.

	Work wear jacket				Work wear fleece				Work wear trousers				Polo Shirt				Crew neck shirt			
	C	P	G	T	C	P	G	T	C	P	G	T	C	P	G	T	C	P	G	T
Tanfield	R	5	1	5				0	R	5	2	10				0				0
Protocol				0				0				0				0				0
Hiatco				0				0				0				0				0
S K P				0				0	B	5	2	10	Red	5	3	15				0
Schmitz	R	60	3	180	N	20	3	60	R	60	3	180	W	270	3	810	R	270	3	810
Explorer	R	50	1	50				0	R	370	2	740	R	400	5	2000	R	370	2	740
K C				0	N	40	1	40	N	66	2	132	N	66	3	198	N	33	2	66
Bison	R	10	1	10	Bl	10	1	10	B	50	2	100	B	50	3	150	B	50	2	100
				0				0	Bl	10	2	20	Bl	10	3	30	Bl	10	2	20
College				0				0				0				0				0
Lamplas	B	30	1	30	B	10	1	10	B	30	2	60	B	20	3	60				0
Electrak				0				0		50	2	100		50	3	150		20	2	40
Donyal				0				0				0				0				0
N S T				0				0				0				0				0
Doby				0				0				0				0				0
Larzep				0				0				0				0				0
Dyer				0				0				0				0				0
R F L				0				0				0				0				0
C A V				0				0				0				0				0
Ionbond				0				0				0				0				0
Microbac				0				0				0				0				0
F G M				0				0				0				0				0
Maritime				0				0				0				0				0
Cuisine				0				0				0				0				0
				275				120				1352				3413				1776

	Boiler suit (poly)				Boiler suite (Proban)				High Visibility vest				High Visibility jacket				Safety Boots			
	C	P	G	T	C	P	G	T	C	P	G	T	C	P	G	T	C	P	G	T
Tanfield				0	R	218	3	654				0	Y	5	1	5	Bl	235	1	235
Protocol				0				0				0				0	Bl	4	1	4
Hiatco				0	N	8	3	24				0				0	Bl	8	1	8
S K P				0				0				0				0	Bl	5	1	5
Schmitz	R	180	3	540	R	30	3	90	Y	20	1	20	Y	60	1	60	Bl	270	1	270
Explorer	R	12	3	36				0				0				0				0
K C				0				0				0				0				0
Bison				0				0	Y	10	1	10				0	Bl	60	1	60
				0				0				0				0				0
College	R	100	3	300	R	80	3	240				0				0	Bl	100	1	100
Lamplas	B	55	3	165	B	3	3	9	Y	8	1	8	Y	8	1	8	Bl	100	1	100
Electrak		2	3	6		2	3	6		5	1	5		5	1	5		50	1	50
Donyal				0				0				0				0				0
N S T				0				0				0				0				0
Doby				0				0				0				0				0
Larzep				0				0				0				0				0
Dyer				0				0				0				0				0
R F L				0				0				0				0				0
C A V				0				0				0				0				0
Ionbond				0				0				0				0				0
Microbac				0				0				0				0				0
F G M				0				0				0				0				0
Maritime				0				0				0				0				0
Cuisine				0				0				0				0				0
				1047				1023				43				78				832

Legend: Colour=C; Personnel=P; Garment=G; Total=T; Royal=R; Yellow=Y; White=W; Navy=N; Blue=B; Black=Bl; Special requirements - Explorer - no external buckles, buttons, press studs, zips

Table 12: Work wear survey

7.3.4 Bulk purchasing trial with welding gas

After the initiatives with electricity and office stationery had passed successful for involved companies a decision to continue with welding gases was made. The reason for this was a common usage across all companies assuring their involvement and potential benefit. During a DEF meeting, this idea was introduced to Managing Directors (or other participating senior management) and the approach to fax a form was agreed. After a period of several attempts pursuing the return of the fax back form without significant success it was decided to go ahead according to the information collected in 7.3.1. Current and new suppliers of welding gas were contacted.

Unfortunately, only demands for a "what-if" scenario could be provided but suppliers of industrial gas are large multinational companies such as BOC or Linde Gas. These companies do operate their own electronic purchasing system and do not accept a small consortium as a trade partner.

One problem on the DEF member company side was the time companies had to spend on data collection or the availability of data in general. Companies are too busy with operations to contribute time towards the development of a purchasing collaboration or data; in particular, invoices were frequently missing. Another inhibitor to the change of an industrial gas supplier is the necessary and costly modification of related tools and equipment.

Both problems the supplier reluctance to quote based on forecasted data and easy data collection at DEF member side were to be addressed by an appropriate collaborative procurement data collection software prototype that is introduced in Chapter Six.

7.3.5 Evaluation of the prototype software

As discussed in Chapter 7.3.3 the demand aggregation for industrial work wear was conducted using an Excel spreadsheet. The evaluation of the collaborative purchasing software is demonstrated now simulating how to be applied within this context. DEF member Explorer Group Ltd initiated this initiative during a Forum meeting giving other members the opportunity to add their individual demands and purchase collaboratively work wear. Therefore, the required items of the Explorer Group were added to the hub demand database and submitted to the collaborative procurement workflow (Figure 56).

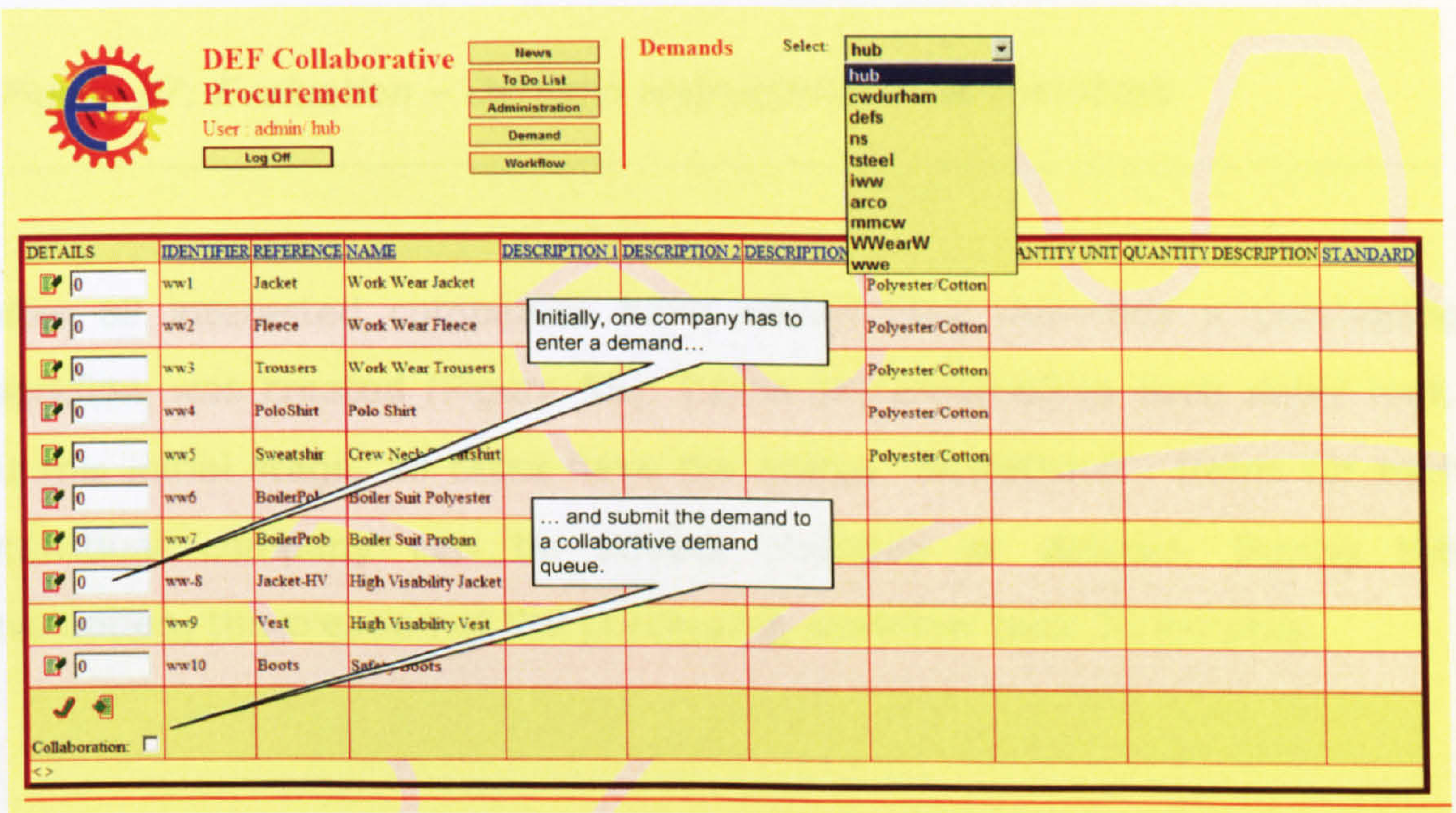
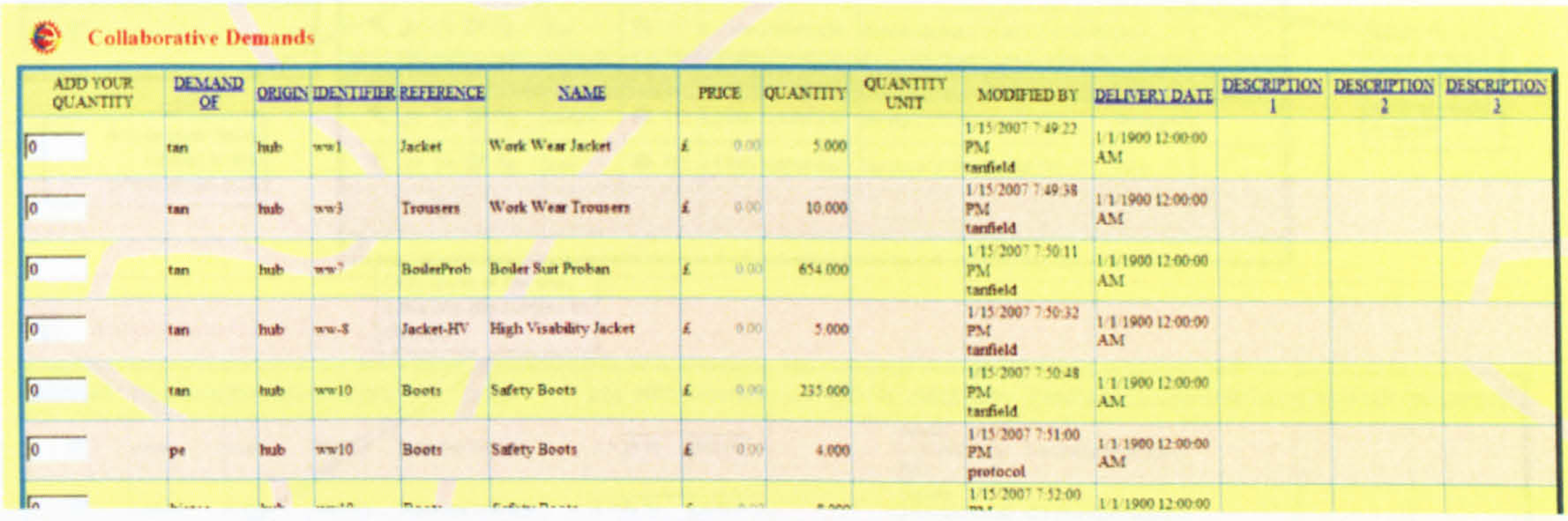


Figure 56: Evaluation – Entering the original Demand

Subsequently, interested companies can view collaborative demands on the start screen (Figure 57) and add their own requirements to the collaborative purchasing of the consortium. In this example, DEF members Tanfield Group (tan) and Protocol Engineering (pe) have a mutual demand for

"Safety Boots". During the evaluation, the entry of demand data took approximately 60 minutes for the 65 items of the entire group (Table 12).

Beside the creation of the initial items at the hub database, data entry into the system was conducted using a unique company user ID.


Collaborative Demands

ADD YOUR QUANTITY	DEMAND OF	ORIGIN	IDENTIFIER	REFERENCE	NAME	PRICE	QUANTITY	QUANTITY UNIT	MODIFIED BY	DELIVERY DATE	DESCRIPTION 1	DESCRIPTION 2	DESCRIPTION 3
0	tan	hub	ww1	Jacket	Work Wear Jacket	£ 0.00	5.000		1/15/2007 7:49:22 PM tanfield	1/1/1900 12:00:00 AM			
0	tan	hub	ww3	Trousers	Work Wear Trousers	£ 0.00	10.000		1/15/2007 7:49:38 PM tanfield	1/1/1900 12:00:00 AM			
0	tan	hub	ww7	BoilerProb	Boiler Suit Proban	£ 0.00	654.000		1/15/2007 7:50:11 PM tanfield	1/1/1900 12:00:00 AM			
0	tan	hub	ww-8	Jacket-HV	High Visability Jacket	£ 0.00	5.000		1/15/2007 7:50:32 PM tanfield	1/1/1900 12:00:00 AM			
0	tan	hub	ww10	Boots	Safety Boots	£ 0.00	235.000		1/15/2007 7:50:48 PM tanfield	1/1/1900 12:00:00 AM			
0	pe	hub	ww10	Boots	Safety Boots	£ 0.00	4.000		1/15/2007 7:51:00 PM protocol	1/1/1900 12:00:00 AM			
									1/15/2007 7:52:00	1/1/1900 12:00:00			

Figure 57: Evaluation - Demand aggregation of all members

After all interested companies have added their demands a purchasing workflow was created (Figure 58). Items are assigned to each detail task. At this initial stage, all tasks have the status "SCHEDULE". Items for each individual company can be added, changed or deleted. During this evaluation, the creation of the purchasing workflow took 30 minutes.

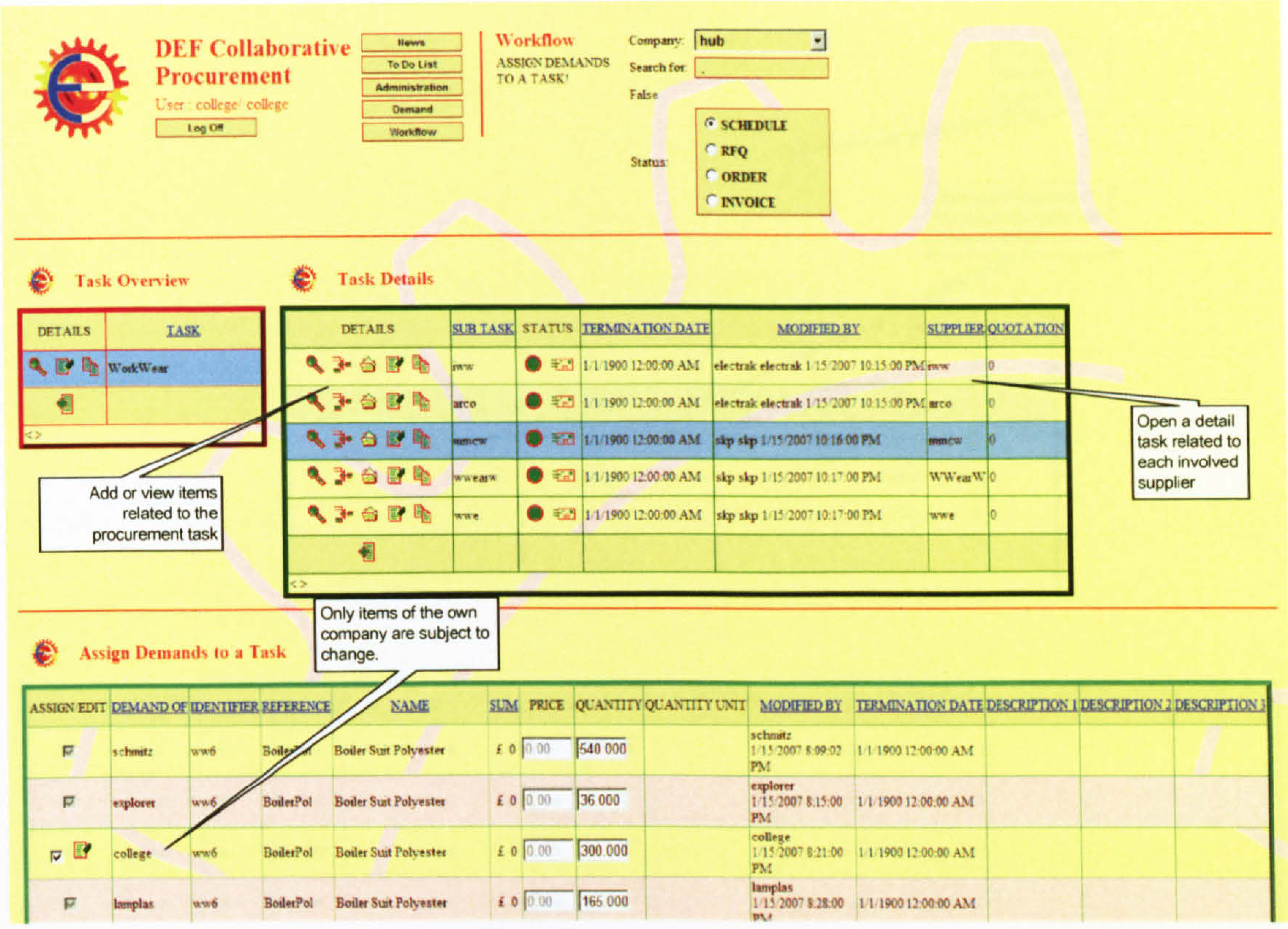


Figure 58: Evaluation - Workflow creation with each involved supplier

To proceed, the status of the tasks has to be edited (Figure 59).

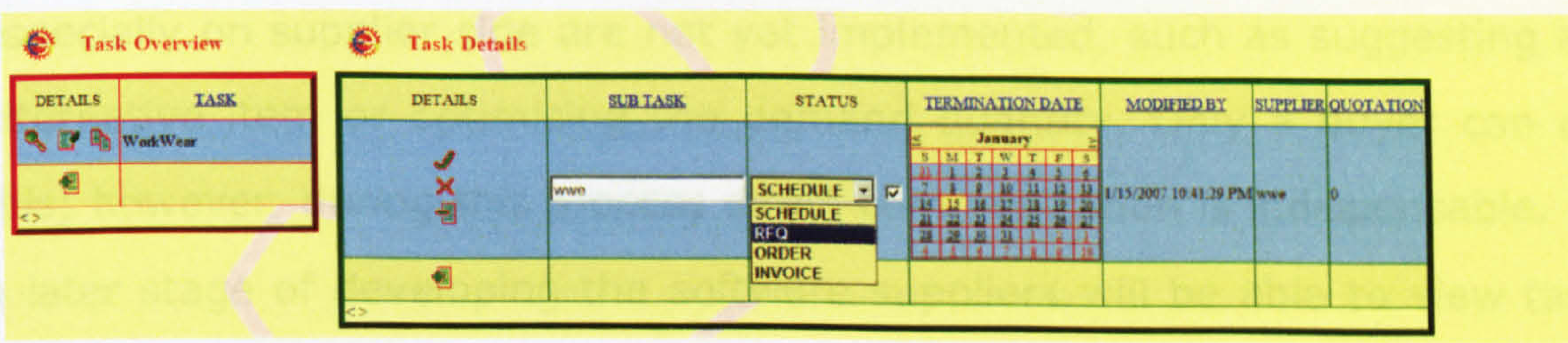


Figure 59: Evaluation – Edit the task status to proceed

Changed tasks will appear under the status RFQ and after submitting to the supplier, the light changes from green to yellow (Figure 60). This indicates the stage "waiting" for a quotation.

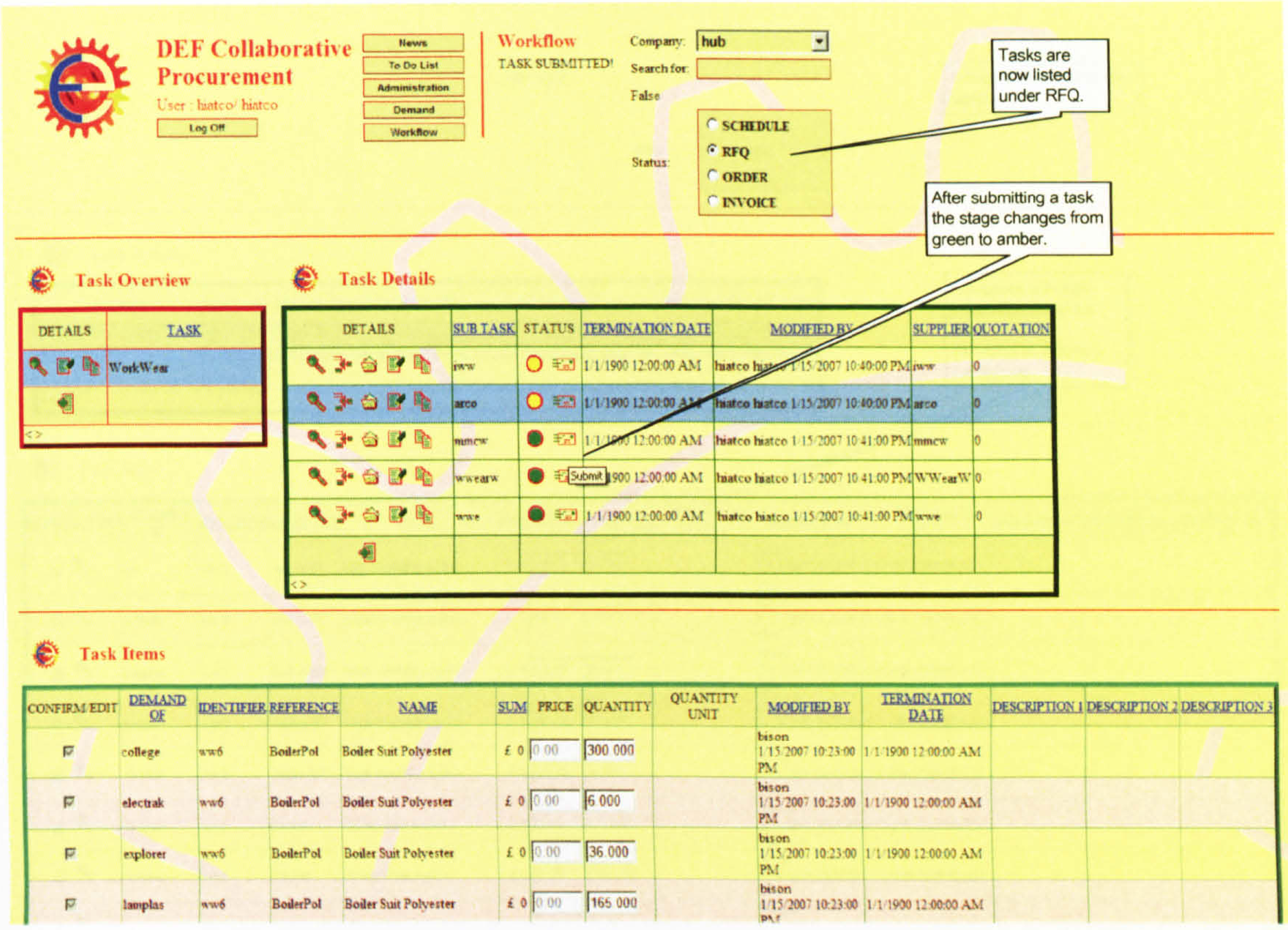


Figure 60: Evaluation – Submit a RFQ to each involved supplier

It is now depending on the invited supplier to provide at least price information (Figure 61). Within this software prototype many features, especially on supplier side are not yet implemented, such as suggesting an alternative item or optimising the demand quantity. Only a buyer can do this; however, during this process direct communication is indispensable. At a later stage of developing the software suppliers will be able to view task with the status SCHEDULE too aiming at an early integration.

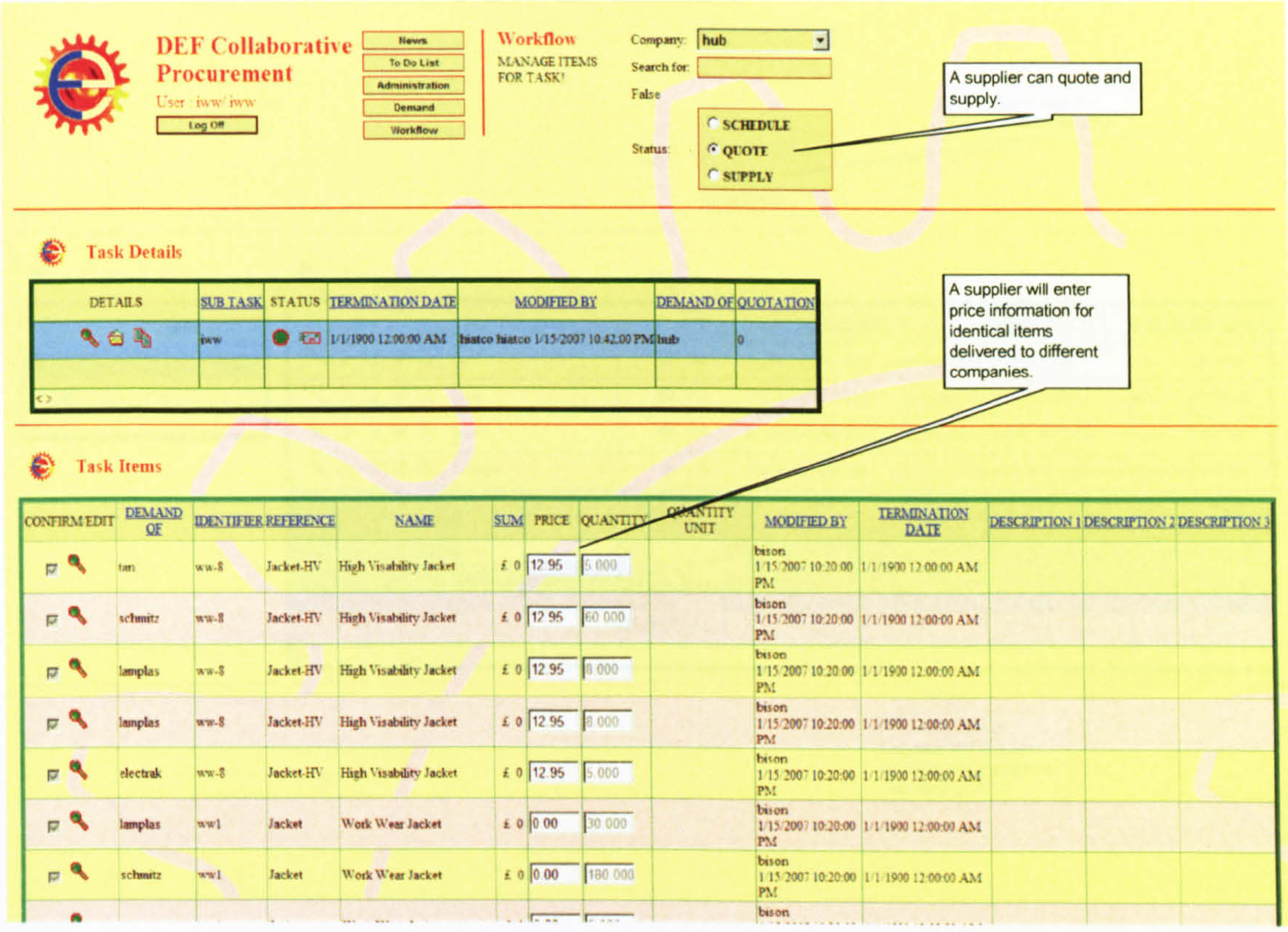


Figure 61: Evaluation – Supplier gives a quotation

The duration to enter the information on supplier side was approximately 60 minutes. After submitting, the status colour turns yellow – the supplier has to wait for the activities of the buyer side. All participating companies can see a new task with the status ORDER (Figure 62); RFQ tasks disappeared from the workflow screen. On the right side of Figure 62 the overall sum of the quotations is shown. The quotation of the supplier "wwe", for example, is much higher compared with other competitors. The status is set back to RFQ, which means that a re-quoting will be necessary to remain in the process.

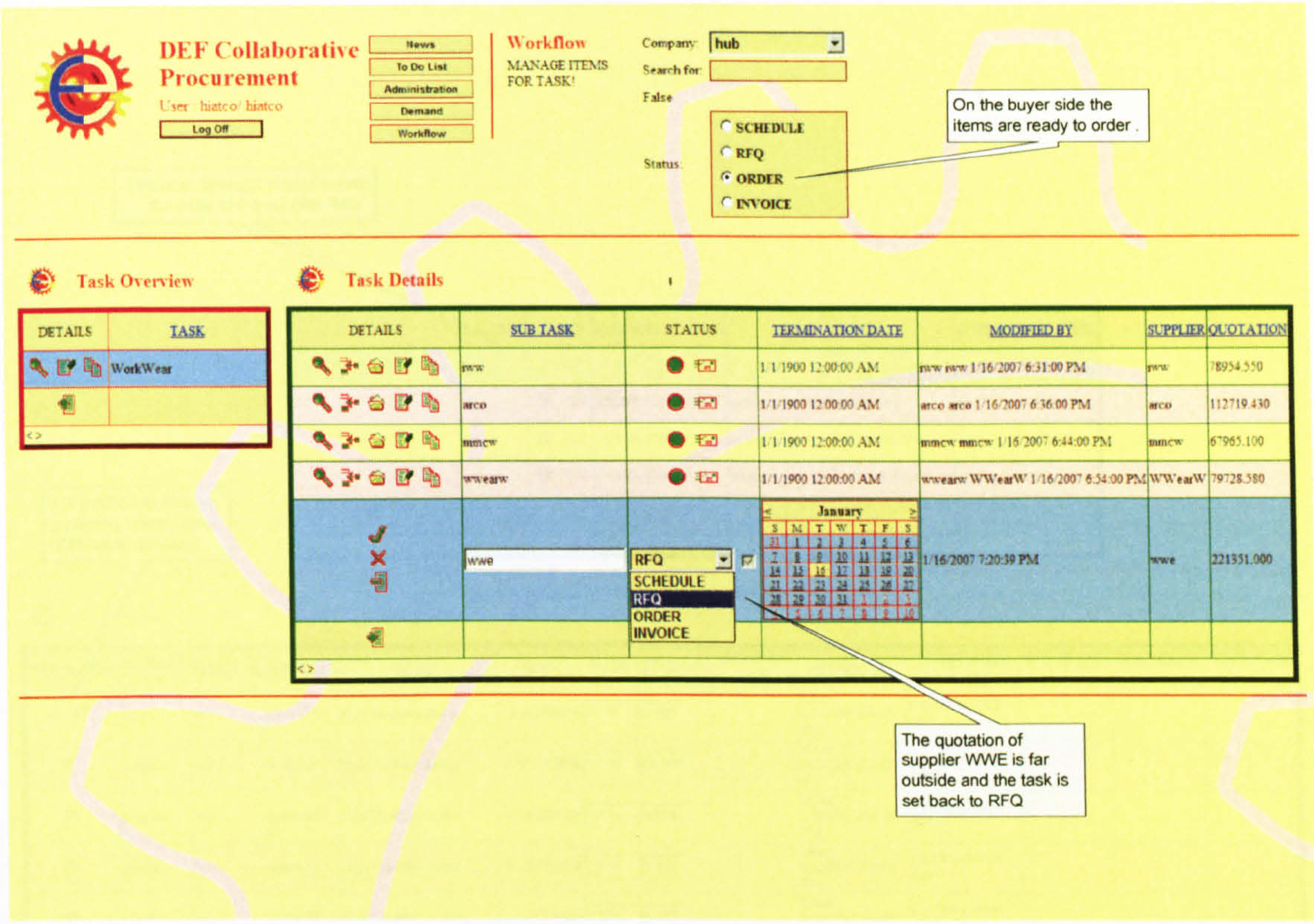


Figure 62: Evaluation – Evaluating the quotations

When submitting an order, the transaction limit of the current user is verified. In this case (Figure 63), the total of the order is higher and the task is locked. To unlock the task, the user has to have a higher transactions limit to authorise the order. After an authorisation, a user with a lower transaction limit can proceed too.

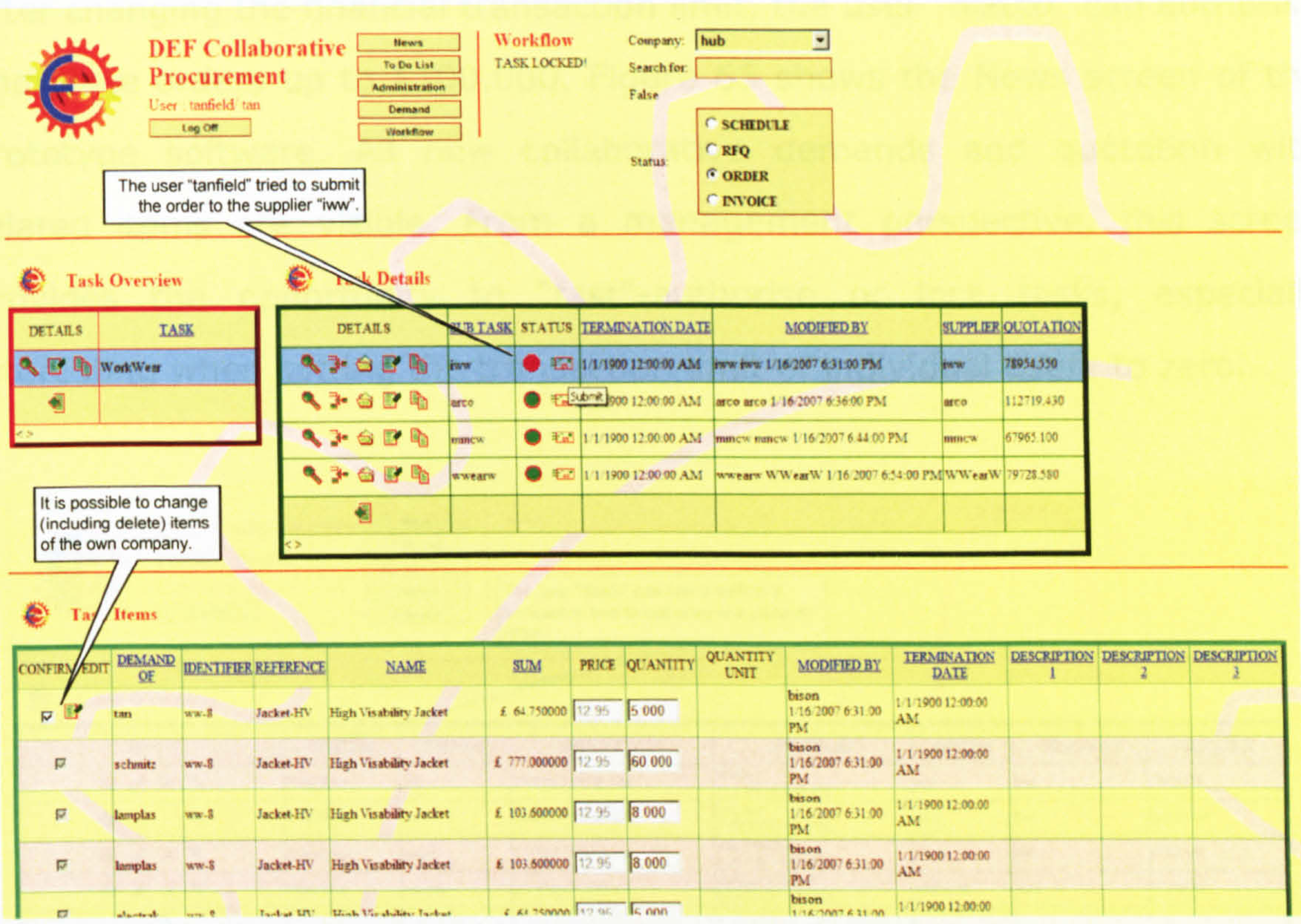


Figure 63: Evaluation – Demonstration of the financial transaction limit when ordering

At this stage of the prototype software from an organisational hierarchy viewpoint, only a financial transaction limit is implemented. Figure 64 shows the change the transaction limit to enable the user "hiatco" to proceed with the order. Setting for example the transaction limit to zero requires for each individual order an authorisation.

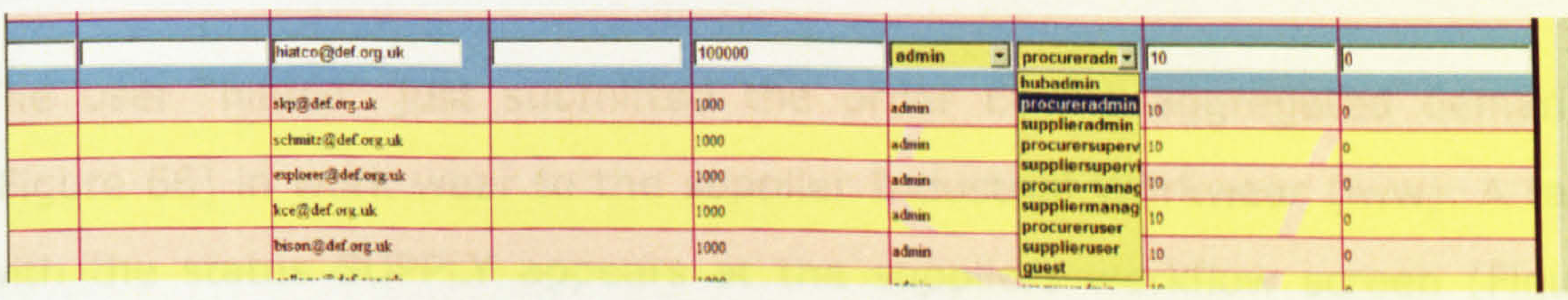


Figure 64: Evaluation – Change the transaction limit to trigger an order

After changing the financial transaction limit, the user "hiatco" can authorise and place orders up to £100.000. Figure 65 shows the News screen of the prototype software. All new collaborative demands and quotation with related items are visible. From a management perspective, this screen provides the opportunity to "fast"-authorise or lock tasks, especially interesting when setting the transaction limit of individual users to zero.

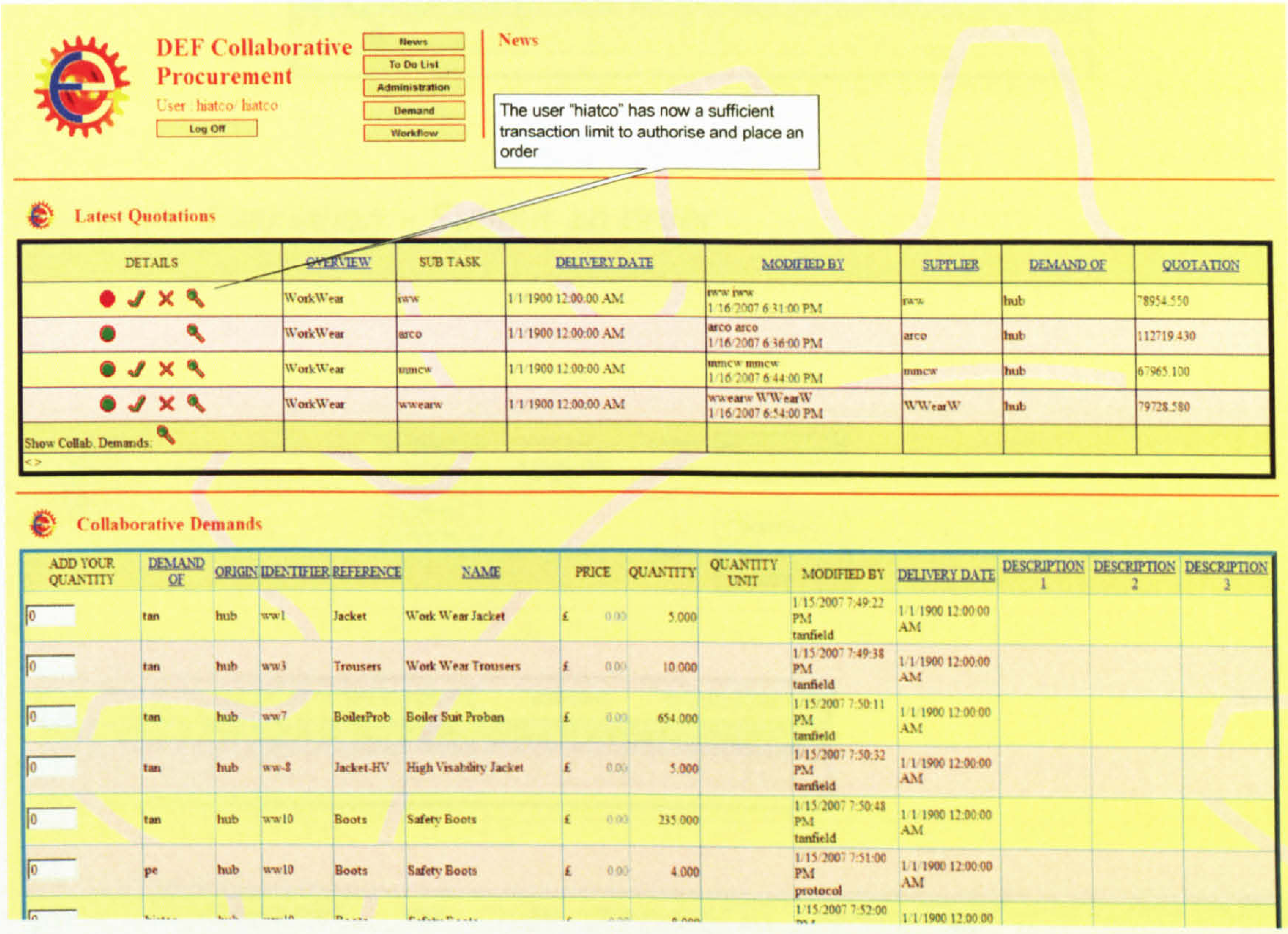


Figure 65: Evaluation – Start page with latest quotations and collaborative demands

The user "hiatco" just submitted the order of the aggregated demands (Figure 66) in work wear to the supplier Industrial Workwear (iww). A task with the status SUPPLY appears at the suppliers workflow screen (Figure 67).

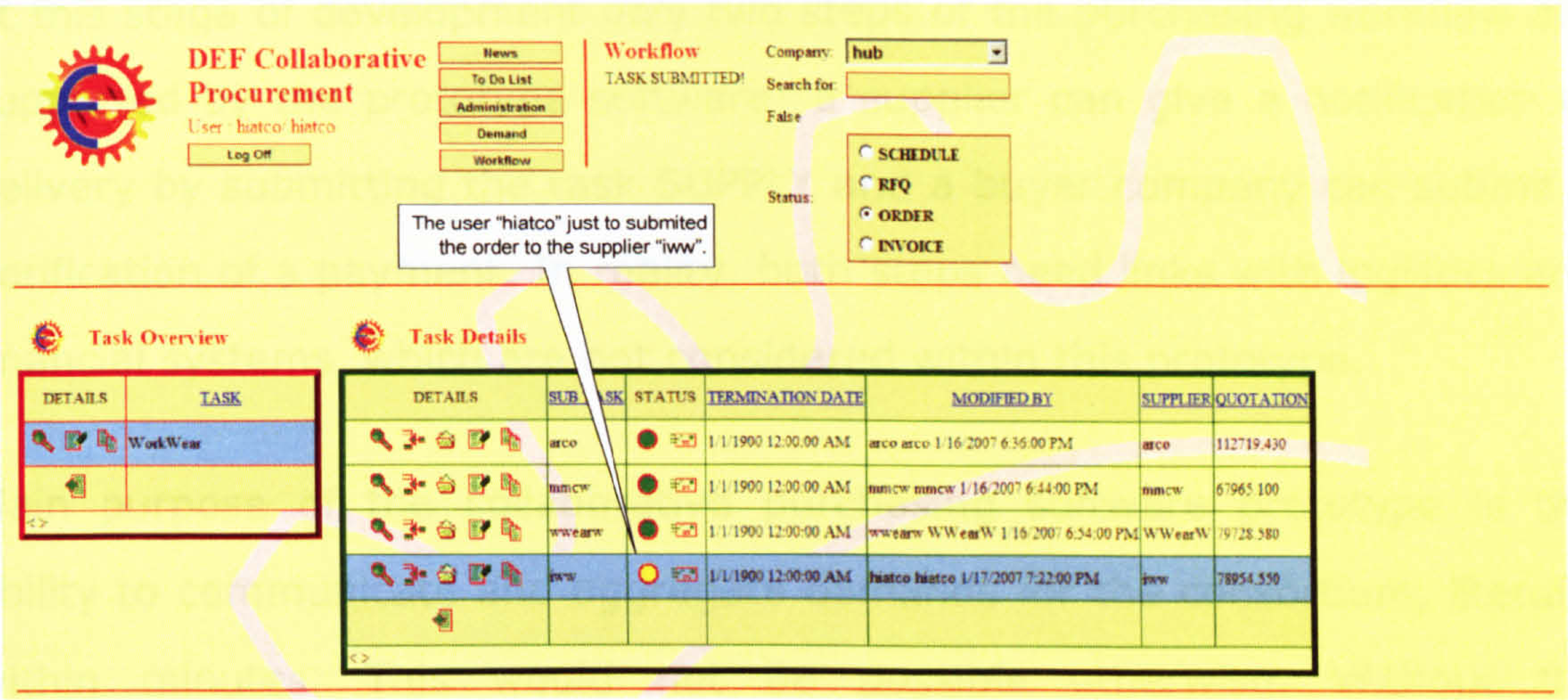


Figure 66: Evaluation – Submit an order

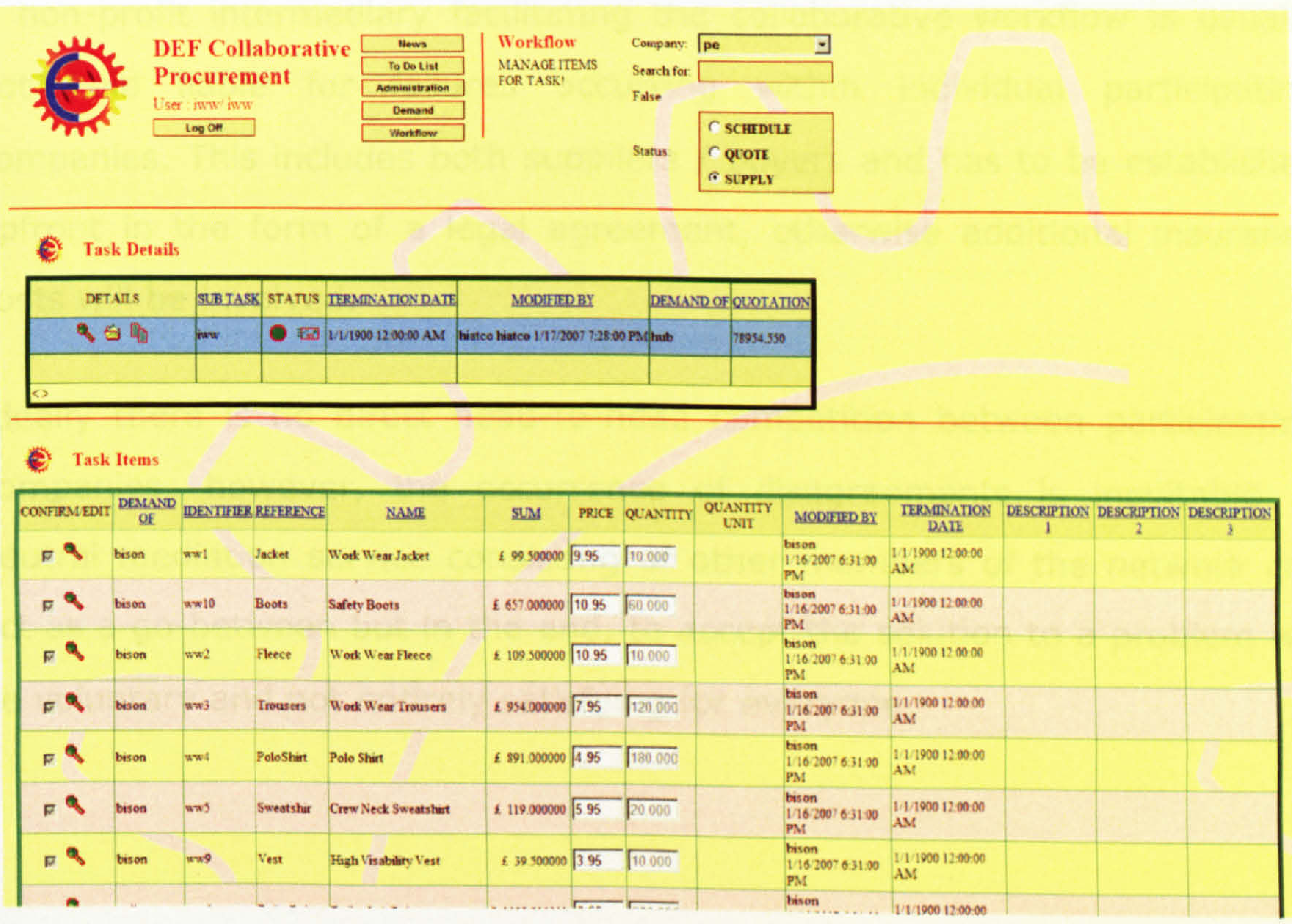


Figure 67: Evaluation – Receive an order

At this stage of development only two steps of the purchasing workflow are supported by the prototype software: a supplier can give a notification of delivery by submitting the task SUPPLY and a buyer company can submit a notification of a payment. In reality, both steps need links with logistics and financial systems, which are not considered within this prototype.

Main purpose of the collaborative purchasing software prototype is the ability to communicate and aggregate demands for the consortium, literally within minutes. This would not be possible otherwise. Without the knowledge of the purchasing demands of other companies, a communication discussing the technical parameters never takes place and all companies continue to operate individually.

A non-profit intermediary facilitating the collaborative workflow is usually not held liable for failures occurring within individual participating companies. This includes both suppliers / buyers and has to be established upfront in the form of a legal agreement, otherwise additional insurance costs will be involved.

Ideally there is no direct head-to-head competition between participating companies; however, the occurrence of disagreements is inevitable. A neutral mediation service consisting of other members of the network can act as a go-between but in the end, to accept the solution to a problem will be voluntary and not entirely satisfying for everyone.

7.4 Development model for SME consortia towards electronic collaboration

Possible ways of collaboration are versatile and the approach of an intermediate consortium to facilitate has to be adopted appropriately. Basic driver behind seeking collaboration is always a "weakness" - the inability to fulfil a task with own resources, capabilities or economically viable. Successful SME consortia built up trust as a foundation for future collaborative projects but specific characteristics and requirements of these have to be customised.

The following model focuses on solving a real world problem (Heijboer 2003, Telgen 1988): the systematic approach how to develop SME consortia (Figure 68). General procedural steps are modelled; a solution is suggested and a "trick" is adopted to get there.

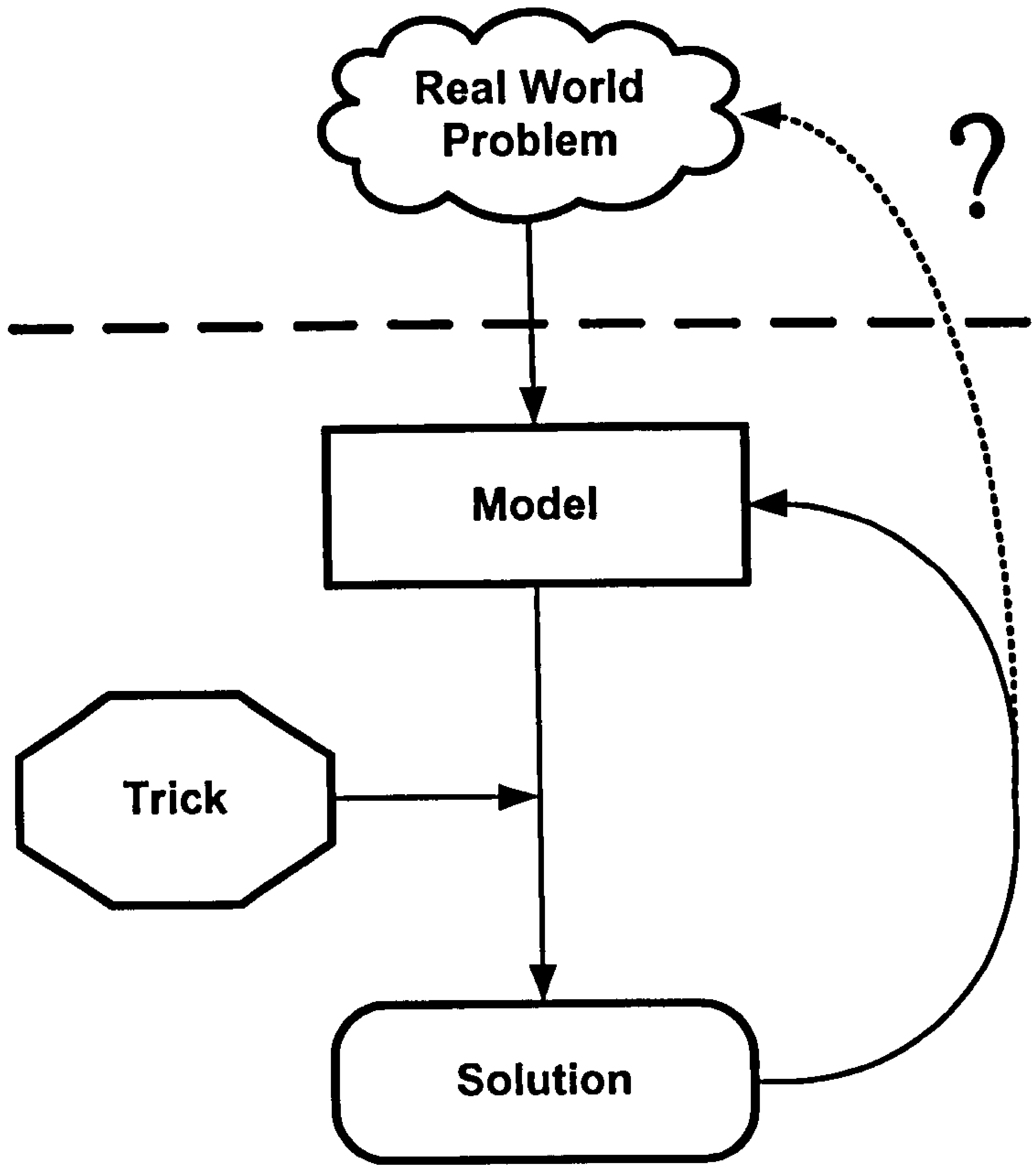


Figure 68: A model acting as a mediator (Heijboer 2003, Telgen 1988)

One main objective of this research project is to create a blueprint of developing inter-organisation collaboration based on empirical evidence collected during the formation of the DEF consortium. The basic assumption is that many SMEs would like to collaborate with other local and well-known neighbour-SMEs (or non SMEs). On a local level personal know-each-other can be assumed, not yet to a level of mutual trust but driving the business networking need. The model (Figure 69) is suggesting the phases of inter-firm collaboration and serves the perspective of a consortium organisation (facilitator, network coordinator) aiming to develop a self-sustainable organisation.

Contrary to many purely quantitative research studies, this thesis focuses on the actual implementation of collaborative processes between SMEs, in particular considering electronic purchasing. The emphasis is on "how" to improve not on investigating "what" is the current characteristic of a specific feature, which is often perceived as less beneficial to practitioners (Gummesson 2000).

For the delivery of services the business priorities of member companies have to be analysed, e.g. DEF activities concern all four strategic priorities for all members (Figure 27). After the initial business strategy analysis individual products, processes, developments and improvement (training) needs should be known. From a perspective of a consortium the initial networking with member companies has to be used to analyse business objectives and derive the own strategy and related activities (Figure 4). In principle, these activities can be pursuit without IOIS support, but much less efficient. Hence, considerations of electronic collaboration are the last part of the model.

The DEVELOPMENT MODEL FOR SME CONSORTIA TOWARDS ELECTRONIC COLLABORATION (Figure 69) constitutes of the following three points:

1. **Analysis of business strategy objectives of individual SMEs for joining a consortium:** There are an innumerable number of companies potentially interested in forming local business consortia, e.g. companies on local industrial estates. Collaboration by forming a consortium is viable when sharing resources outweighs individual activity costs. The following four priorities are addressed through the business strategy of any organisation (1) income generation, (2) order fulfilment (3) NPD and (4) internal improvements. To generate synergy across the business priorities of individual members potential activities for collaboration have to be identified.
2. **Development of collaborative activities strategy and working processes:** For individual companies customer requirements influence the business strategy down to workflow processes. In case of forming a consortium suitable activities assigned previously under the business priorities of several individual member companies will be transferred.

They are implemented into the strategy of the consortium as core activities, a common work process has to be agreed with members and communicated.

3. **IS supporting collaboration:** Depending on the purpose of the collaboration central and distributed approaches with regards to supporting information systems are possible. Central service related information systems are supported by the consortium aiming to support general business activities, such as a Web site, collaborative purchasing software or off-site online backup facilities. Workflow related decentralised information systems are held centrally at the consortium too, but they require a direct connection to back-office IS and workflow of member companies, such as MS BizTalk for automated invoice or order data exchange.

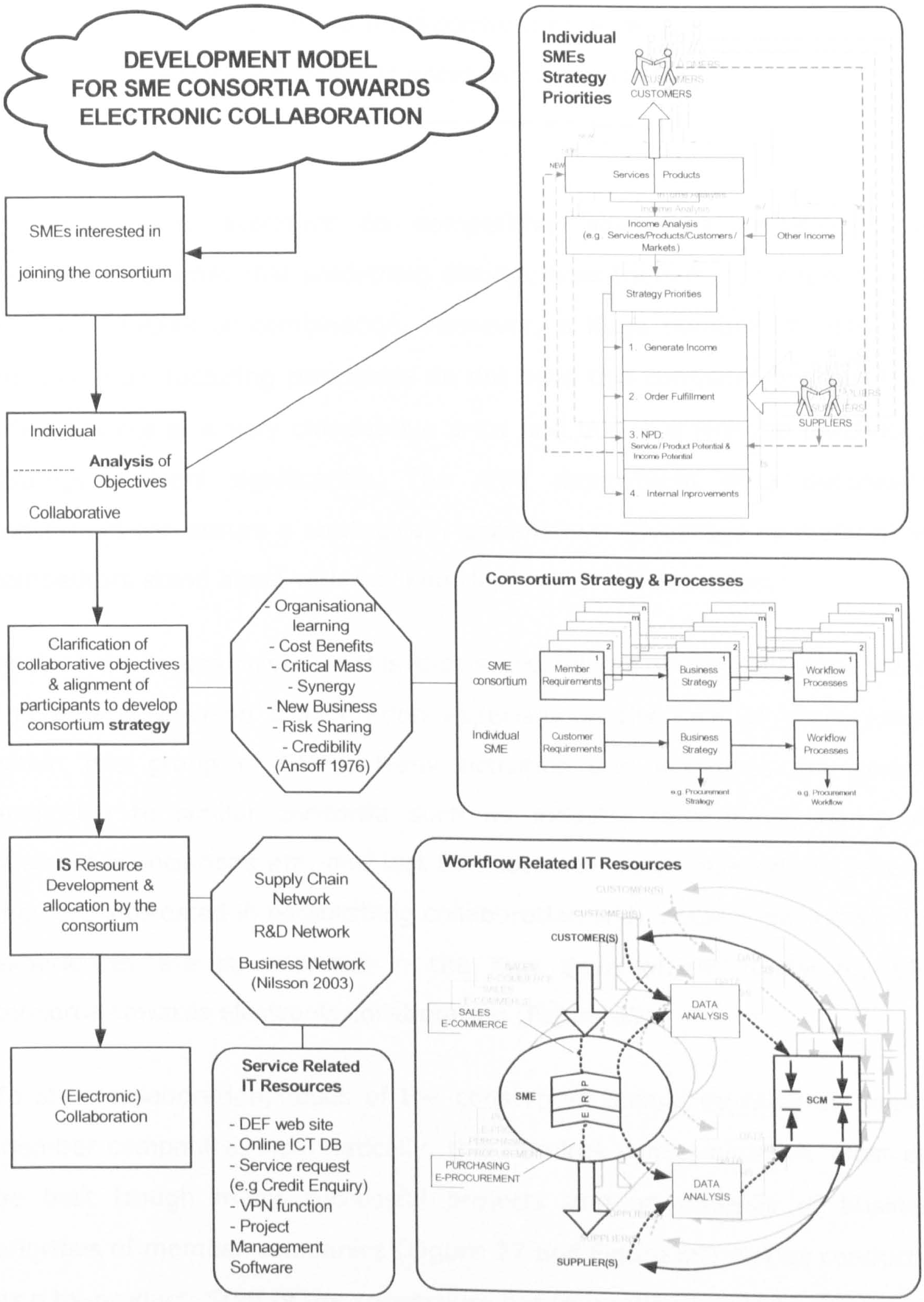


Figure 69: Development model for SME consortia towards electronic collaboration

How can a collaborative consortium develop over time and what is necessary to succeed?

Information and literature on competitive advantage targeting large companies assumes that something distinguishes them from competitors: a product, process or combination. However, a huge number of small and medium manufacturing companies do not have this competitive edge. They offer services at a very competitive price and this is where the purchasing strategy matters significantly. The right deployment of a purchasing consortium can assure a strategically competitive advantage as many other competitors stand alone with no "knowledgeable" collaboration.

Most of the issues raised in this thesis are related to the DEF consortium and how to develop collaboration especially in the field of procurement within this group of SMEs. Many activities and initiatives are generic applicable to similar consortia such as industry federations, non-profit business associations etc. and last but not least other researchers (even if they are interested in establishing collaboration with industry partners). The experiences are summarised in the new development model for SME consortia towards electronic collaboration (Figure 69).

To start collaboration, focus of the consortium should be towards helping member companies. Automatically, this requires communication. Trust can be built trough many successful projects and an analysis of business priorities of member companies (Figure 27 and Figure 69) can be conducted as a by-product. Staff of the consortium has to be determined to deliver and to achieve this, professional with research and the acquisition of knowledge. Requests to solve problems concern all business areas.

After knowing companies and staff, servicing the core-business "surrounding" activities of participants will be the aim. Therefore individual member requirements are analysed and where synergies occur services of the consortium are developed (Figure 4 and Figure 69). They are the future core business of the consortium itself; from a company perspective they are performed more efficient in collaboration than individual. Commitment of members, namely the prioritisation of collaborative activities over internal work is important for success. This high rating only occurs if trust is established.

Long-term strive of a consortium should be towards supporting core business of members. Here, the collaboration itself constitutes the collaborative advantage of member companies as it will be very difficult to imitate the consortium. Developing a collaborative consortium is time consuming as it requires trust and commitment.

Collaborative ICT (Figure 69) to achieve common goals relates within this project to Web site information sharing and the collaborative purchasing prototype software. A direct integration of the consortium into members workflow processes (Figure 25) was not yet realised. This will be subject of further work and research.

During this research, the author was involved in all projects described in Chapter 7.2 but predominately focussing on ICT support such as the setting up of a network infrastructure, web site development, custom application development, supply chain data exchange (order/invoice data, production schedules) or simple general consultancy and troubleshooting hotline. This is a rather hidden objective of DEF for this research: the facilitation of additional ICT resources for member companies alongside the actual research work.

8. DISCUSSION, CONTRIBUTIONS AND RECOMMENDATIONS

This final chapter recalls the original objectives, summarises the achievements and discusses how, by meeting these objectives, the work has satisfied the industrial need. The basic intention of this project was to research how to improve the purchasing function of SMEs; this was achieved through the formation of a collaborative consortium. The study sets out to converge varying business priorities, cultures and ICT of a diverse group of companies.

In this final chapter an overview of the research project is given by linking the identified problems with the chosen approach. Then, a summary on how to answer the specific research objectives is presented. This is followed by general conclusions of the research field and the particular contributions of this thesis. Limitation of this thesis and ideas for future research finalise the chapter.

8.1 RESEARCH OVERVIEW: PROBLEMS VS. APPROACH

Based on a theoretical deductive analysis and empirical action research, the result of this study is an approach for SMEs to develop a consortium with the ultimate aim to obtain collaboratively a competitive advantage. This thesis researches the formation of a horizontal consortium with a diverse membership supporting primarily the core business surrounding areas of activities and purchasing. Both, collaboration in general and purchasing in particular are researched with the objective to deploy modern ICT.

Table 13 summarises this thesis by opposing problems to the chosen approach. Discussed throughout this thesis, a potential cost saving strategy for businesses is collaborative purchasing. This was demonstrated through several successful projects conducted by the author (see 7.3). In the long-term a systematic approach is necessary, and within this project realised through:

- Aligning the purchasing of members of the consortium (Chapter Four);
- Automating communication and aggregation demand (Chapter Five);
- Conducting the purchasing workflow electronically (Chapter Six).

APPROACH ▸ vs. ▾ PROBLEMS	Semi structured interview / online survey	Purchasing Framework for SMEs (Chapter 4)	ICT for e-collaboration within a consortium (Chapter 5)	Collaborative electronic purchasing pilot software (Chapter 6)	Case study / development of an SME consortium (Chapter 7)
Varying business priorities		Adaptation of literature models written for large organisations towards utilisation within SMES		Bottom line savings for companies	Joint bids / Joint NPD / Shared Best Practice
Different cultures / internal processes			Knowledge for integration with other supply chain partners	Converging Purchasing Processes	Several cross – hierarchical projects
Trust, commitment & lack of communication	Purchasing Spend Overview Interviews		Trust in the consortium capabilities	Communication between purchasing staff	Communication on many cross - hierarchical levels
Stretched ICT resources / different systems	ICT Survey		Consultancy by the consortium	Shared ICT resources	Shared ICT resources

Table 13: Problems vs. approach of this thesis

8.2 Discussion of the Research Objectives

The state of the art review in Chapter Two identified that (a) the low adoption of electronic procurement for SMEs in general and (b) collaboration in the field of procurement in particular relate to (c) knowledge in the field developed for large organisations and (d) trust and commitment as essential factors when forming a consortium. This was followed by raising research objectives with a subsequent discussion throughout the individual chapters of this thesis.

8.2.1 The purchasing function of SMEs

Large enterprises model the entire supply chain; SMEs need to master only their own position. As very important part of supply chain management (SCM), the purchasing function assures the supply of goods and services required by the business to sell products and services to customers. The purpose of SCM for SMEs can be summarised to linking customer requirements with supplies through the company's value chain (Figure 25).

This thesis develops a purchasing framework for SMEs (Chapter Four), which consists of:

- Strategic considerations;
- Managerial activities & related time frames;
- Item & supplier considerations of the purchasing function.

For a high level assessment of business activities a 4-Priorities model (Figure 27) is introduced dividing activities into (1) income generation; (2) order fulfilment; (3) new product development and (4) internal improvements. From a perspective of a consortium pursuing the development of collaboration in purchasing it is important to consider that related activities are likely to be under priority four "internal improvements".

Under consideration of the lifecycle stage of the product/industry (Table 6) and the current focus of activities, a time horizon for management can be suggested (Figure 29). Within SMEs the purchasing function has to be addressed by various members of staff and hence, appropriate knowledge is required at different hierarchical levels. From a managerial perspective purchasing items have to be related to time frames of activities, these are as follows:

- Short term: assure supply;
- Medium term: maximise the impact of purchasing;
- Long term: shorten the alignment of customer requirements with supply.

Short-term related activities assure the actual supply of the organisation. Collaboration can deliver benefits by using synergies within the consortium to purchase items of low importance more efficient. Electronic purchasing in general helps to streamline processes through electronic workflows such as demonstrated in the collaborative electronic purchasing prototype software.

Medium-term managerial activities support the monitoring of purchases over time and process data for further discussion with other departments or top management. Important purchasing items, which contribute in particular to the profit, need to be identified and monitored. Less important items should be bought in collaboration. Both scenarios are domain of electronic purchasing, namely, process automation to increase efficiency and process systematisation to enable long-term monitoring.

Long-term managerial purchasing activities help developing the right corporate strategy. Input of the purchasing function relate to purchases of parts of new designed products or out-sourcing/in-sourcing of important activities.

In general, a new approach of purchasing item classification is suggested relating the commonly used ABC analysis to Strategic / Leverage / Bottleneck / Routine item classification (Figure 35).

The purchasing framework was used when networking with participants to introduce collaborative purchasing and more generic to identify potential areas of collaboration. A high priority within the business strategies (Figure 27) equals to a high interest to participate. The purchasing function can be associated with priority two "Order Fulfilment", however, collaborative purchasing only scores at level four "Internal Improvements". Although there is still much work to be done with regards to testing and developing individual metrics, the research provides a new holistic framework for the purchasing function of SMEs.

8.2.2 ICT infrastructure to support collaboration

Analysing past and current business execution software, future trends were derived (Figure 22). This is brought into the context of a collaborating group of SMEs under the theme of "connecting ERP islands" (Figure 39). In the field of purchasing, where information (such as catalogue data, RFQs, quotations) needs to be exchanged frequently, the "e-translator" model is introduced (Figure 41). Based on the above new collaborative electronic purchasing pilot software was developed.

The alignment of ICT systems of individual members of the consortium can only be a subsequent task – a means to fit the purpose, not a purpose itself. Hence, ICT resources are available to support product or service delivery and many SMEs use ERP systems to control internal business processes but advanced adoption or customisation to deliver collaboration is beyond these capabilities.

With the advent of the Internet and ADSL technology, a direct connection with a sufficient speed is available; an intermediary consortium can deliver a service enabling member companies to collaborate even in real time. A central hub executes data translation or mapping tasks to enable communication between different systems – in this research called "e-translator" (Chapter Five). This implicates from an individual company's point of view to define "collaborative data" and use import-export modules of the e-translator. However, assuming that the "collaborative data" set is subject to data processing, an additional visualisation of a workflow is necessary – in this research called "purchasing data triplet" (Figure 47). As an example, the collaborative procurement prototype software was developed (Chapter Six).

To support collaborative activities, central service related ICT was deployed, including a Web site and collaborative purchasing pilot software. At the next level, decentralised workflow related ICT is deployed centrally at the consortium too but requires direct integration into consortium members systems; a collaboration enabled ICT infrastructure of the entire consortium is necessary.

8.2.3 Collaborative electronic purchasing

Many times, the typical roll-out of electronic purchasing software (Heijboer 2003) is not appropriate for SMEs as this assumes financial resources, IT integration knowledge and business process management. As shown in the very low number of electronic procurement implementations amongst SMEs, cost and complexity outweigh overall benefits to the business (McDonagh & Coghlan 2000). On the other hand, inherent opportunities justify a collaborative approach by forming a consortium as discussed throughout this thesis.

Usually, companies do not procure/source entirely new products, but rather well known current requirements for their own production. It is also important to consider annual one-off items where companies negotiate the pricing structure for the next year. In both situations, there is already a group of existing suppliers, which have to be benchmarked. For an initial start, this can be done by simply interviewing procurement staff.

Initiatives such as collaborative purchasing are popular when delivering substantial savings, demonstrated with electricity buying (Chapter 7.3.2). Here, a consortium can act independently, supplied only with a relative small amount of information from companies. Another example is the contract negotiated with an office stationary supplier based on the rough turnover estimate (Chapter 7.3.1). A final example of an initiative of this kind is the purchase of work wear (Chapter 7.3.3). Collaborative purchasing within this research worked best for one-off projects where the consortium organisation made a significant time contribution.

Important prerequisites for collaboration in purchasing are mutual trust and a subsequent announcement of a potential demand. After co-ordinating and conducting collaborative projects in purchasing manually it became evident that only using a Web-based software tool where members of the consortium can submit their own demands and see demands of other members meets the requirements. Hence, the priority of this prototype is synchronisation and demand aggregation for common purchases across several companies. As a result of this research project collaborative procurement prototype software is available and members of the consortium can access the procurement web client to either collaborate or purchase as an individual company.

As the first important pre-requisite to conduct the electronic procurement process, the selection of articles is possible from an individual company's database, a database of each registered supplier or a standard hub database of the entire consortium. Next important precondition for collaboration is to communicate a demand to other members of the consortium. Subsequently, other companies can add their individual requirements of the same item.

Within the developed software prototype the purchasing workflow passes through the stages SCHEDULE – RFQ – QUOTE – ORDER – SUPPLY - SETTLE ACCOUNT. The new concept of a Procurement Data Triple is introduced; the

(1) actual purchase items, (2) related documents and (3) purchasing workflow represent all necessities involved.

An evaluation of the software (Chapter 7.3.5) in comparison with a manual collaboration approach demonstrates the advantages. This assumes that the purchasing staff at participating companies is familiar with the software and committed to use the software. In this context, commitment is shown when individual purchasing activities are delayed and collaborative work is prioritised. This is necessary for all inter-organisational collaborative business processes of a consortium, but stresses available resources within SMEs as compared with their potential short-term benefit towards business priorities.

A critical process when buying collaboratively is the communication of current demands. Within this research, companies that are participating in a consortium can view other members' demands or publish their own demands. For the process of inviting suppliers and negotiating conditions there has to be a volunteer; other participants only monitor progress and communicate with the "specialised volunteer". Only the knowledge (and staff) to evaluate all other supply areas remains with each member of the consortium. The development of "competence centres" held at individual member companies potentially offers a significant (staff) cost reduction.

Another option would be to transfer the complete purchasing task to the consortium. However, when outsourcing the entire process the associated costs and process risks will rise. A further commercial cost/benefit analysis of using electronic procurement software within a consortium requires a significant amount of user information, which is not available to date. This will be subject of future research.

For the development of a collaborative purchasing consortium, a variety of activities and knowledge are necessary. To consider long-term purchasing planning, the high level management of participating companies should act as a facilitator assuring selection, time commitment and approach of involved purchasing staff. Workshops to assure a mutual approach, discuss best practice in purchasing and supply chain management are necessary especially at the beginning of the project. After all, it is the purchasing of several companies and accordingly, time commitment and sufficient resources to conduct training have to be assured!

Technology is only a means to an end. Even though the development of custom software is easier than ever before, dedicated resources equal to training and managing commitment are necessary to develop customised collaborative purchasing software. However, a special ICT company or similar to this research, a local University could deliver this part of the project.

In the future, the majority of SMEs will conduct the purchasing function as a core business process. Most likely exceptions are MRO (Maintenance Repair and Operation goods) or C-Articles (see 4.5.1). This could be the business of a trusted intermediary. However, defending this confidence will become increasingly difficult with the growing price transparency provided by the Internet. On the other hand, even the "most unimportant" item will be bought when reaching a certain level of inconvenience. Many times the cost of the process is higher than the item cost itself. To accomplish an economically efficient process the question 'who to trust' has to be answered. The suggestion as a result of this thesis is: Trust ourselves! For a group of SMEs forming a collaborative purchasing consortium, the development of competence centres is desirable.

As discussed previously, trust is not built at e-speed (PriceWaterhouseCoopers 2000) and this is true for collaboration of any kind. Especially in the field of procurement, this is due to the huge number and complexity of options and related preferences. In addition to the purchasing process costs themselves, the strategic priority of the purchasing function and the available time contribution of consortium member companies are very low. On the other hand, the procurement function is amongst the core business functions of most companies and can only be carried out with a high level of involvement. Beyond these intra-collaboration issues, suppliers have unrealistic expectations of the purchasing authority of intermediaries. Finally, suppliers usually respond not enthusiastic towards purchasing consortia. However, top business priority of a supplier is the generation of income, too. Hence, it is an assertion of this thesis that the crucial success factors manifest in:

1. Commitment of the purchasing staff to communicate demands to the consortium and
2. Involvement of high level management to coordinate the assignment of a "lead company" - the competence centre of the consortium.

The sale of services and products is the most significant business priority for all companies (Figure 27). Hence, it is most likely that companies develop their own on-line sales facilities first before integrating other business functions electronically. In the near future multi-catalogue electronic procurement systems will probably not integrate or replace web based on-the-spot procurement. As data integration on the procurement side of the business requires investment into software or programming capabilities, the utilisation of Internet based product searching combined with credit card payment will be of increasing importance for the purchasing process of SMEs in the future.

8.2.4 Development of a collaborative consortium

A perceived deficit pushes an organisation into action driving towards a particular objective – the motive (Bolstroff 2002). In the case of this research: Collaboration aims to overcome individual companies' weaknesses by combining complementary skills and resources.

Based on the experiences gained during this project a new development model for SME consortia towards electronic collaboration (Figure 69) is introduced. Through many successful small projects with participants (Chapter Seven), trust and commitment within the consortium developed over time. During these smaller projects the business activities of member companies were analysed (Figure 27) to derive and develop core services of the consortium (Figure 4).

All regular activities in SMEs relate to strategic business priorities (Figure 27); of course, there are special activities such as voluntary mentoring within the community (see Chapter 7.2) or owner-manager lifestyle related tasks and other exceptions. A consortium only emerges, when members perceive a benefit. Therefore, as a start in particular the core business surrounding activities of members have to be analysed in converged into collaborative activities of the consortium.

This only supportive role of a consortium will change when a synergy between members of the consortium creates a collaborative advantage, which cannot be imitated. The "consortium coordination" becomes a product itself, to name an example: Derwentside Engineering Forum Integrated Engineering Services are at the early development (see Chapter 7.2). All costs related to conducting a networked business can be considered as transaction costs, namely partner search, contracting, monitoring or conflict resolution. A low level of trust requires more formal contractual agreed structures for collaboration (Johanson & Mattson 1987, Varamaki 1996). Many SMEs do not have time and resources to initiate or maintain these to the level necessary for collaboration.

When developing a horizontal consortium, which does not pursue the marketing of an actual product, often the attention of participating companies is low. This is not surprising as all companies focus on core business generating their income. To both obtain and retain the interest other in demand forms of support have to be delivered to members of the consortium.

These support activities build the trust towards to consortium over time. However, mutual trust itself is not sufficient. Considering the daily workload of SME employees, consortial activities have to stimulate commitment. This is shown when internal activities are delayed and collaborative work is prioritised; therefore, a potential benefit must be evident.

This widens the range of activities significantly but can be used to analyse similar activities across the membership. On the other hand, the involvement into a multitude of projects at several hierarchical levels of member companies meshes the consortium with member companies. This is the main priority for an intermediary organisation as it is in turn the core business – the provision of activities surrounding the core business of member companies. The involvement into several initiatives with companies will generate cross-departmental communication but also provide the opportunity to network and communicate other "sleeping" initiatives. This constitutes a possible way of developing a collaborative consortium of independent SMEs.

8.3 Contributions to Theory and Practice

If the fundamental mission of research is to contribute to the body of knowledge, then the primary objective of action research is the contribution to managerial practice (Bourner 2005). This thesis develops two new concepts:

1. A purchasing framework for SMEs;

2. A collaboration model to establish a consortium of SMEs.

The most significant contribution to practice is the detailed demonstration how to develop a collaborative consortium.

8.3.1 Purchasing framework for SMEs

Purchasing is a core business function for all manufacturing companies. A literature review revealed that theory and business support software in this field is aiming at large organisations; considerable financial and personnel resources are necessary for an implementation. Comparing the potential benefit and the associated risks with the perceived importance level of purchasing, which is mostly administrative, SMEs do not invest towards state of the art purchasing facilities.

The risk was effectively removed by forming an independent consortium (which serves other business functions as well) and providing a voluntary model to participate. However, for the purpose of collaboration a mutual understanding of the purchasing process needs to be established. This is the function of the purchasing framework for SMEs developed within this thesis.

The suggested framework includes (1) considerations of the purchasing function within the corporate strategy, (2) time horizon of managerial purchasing activities and (3) administrative purchasing item related tasks. Basic idea is to provide metrics to link income with related purchases and subsequently prioritise activities to assure the supply. This framework was communicated during the formation of the collaborative consortium and provided a guideline for the selection of appropriate items.

8.3.2 Collaboration model for SMEs

Based on a literature study of collaborative networks it was found that to date the research relates to investigate the characteristics of currently existing networks. The particular contribution of this research is in developing a collaboration model for SMEs that explains how to establish collaboration (Figure 69).

An important pre-condition of collaboration within this project was local proximity. The management of participating companies should have a positive attitude and willingness to network with others, which is usually the case. Our model considers the business strategies of individual companies (see 4.2) aiming at the identification of activities suitable for collaboration. After communication and adjustment of internal processes the external collaboration emerges gradually depending on the development of mutual trust and the ability of the consortium to evoke commitment.

From the perspective of a consortium the development of an ICT infrastructure required for electronic collaborations is explained. Inter-organisation communication and workflow processes can only be efficient when using modern ICT. This thesis demonstrates how to develop services at a central ICT hub but also considering the integration of the distributed individual IT systems of members of the consortium.

8.3.3 Development of a collaborative consortium of SMEs

This thesis extends research by applying the work into practice through managing the formation of a consortium. Motivation of this research is to provide participants the tools to address collaboration in purchasing by increased knowledge, methods and technology; this will be available to academic community and management too (Alloway 1977). As set out in the objectives in Chapter One, to satisfy all involved parties the project did address for the:

1. Industry participants: Deliver tangible bottom line benefits;
2. Consortium: Develop a method and IT infrastructure for electronic collaboration;
3. Researcher: Research the process and contribute to the knowledge in the field of collaborative electronic purchasing.

One criticism of management research is that it is written predominately for academic purposes (Behrman & Levin 1984, Perry & Zuber-Skerritt 1992) and the perceived impact in the business world is "virtually nil" (Porter 1988). The only formal academic solution of a problem is not fully satisfying, even purely from a research perspective. As long a solution it is not used to a large extend in practice there is room for further research. This is often down due to the complexity of implementation vs. potential outcome. A problem should be considered as academically solved when costs for methods and theory for implementation are lower than potential outcome. Then the implementation will become entrepreneurial risk as all business is today....

We have demonstrated that for the development of a collaborative purchasing consortium a variety of other collaborative activities should also establish over time. This led though many areas of enquiry and much has been achieved on the way.

8.4 LIMITATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Limitations: Most considerations within this thesis are made from the viewpoint of the intermediary consortium Derwentside Engineering Forum Ltd. (DEF), which was formed by a group of SMEs to pursue mutual interests more efficient. This kind of industry-based research is bound to real-world developments and accordingly, placed in an uncontrolled environment. Due to the number and complexity of variables, to date the purchasing framework and the collaboration model can be only considered as qualitative and conceptual. The collaboration model needs to be introduced with industry associations or organisations related to local economic development for further testing. This is true for the purchasing model as to date quantitative experiments to measure individual metrics were beyond the scope of a single thesis.

In the following four examples are given where further research might be useful:

#1: Large companies capable of delivering a variety of services will charge premium rates in addition to the actual work. With the current generation of emerging ERP systems, a true real time integration of previously internal company data seems to be possible. Many of these incorporate APIs to enable data interchange. In the past this data change and data input was only possible using screen input masks; a user had to process one item at a time. Important future trend involving ICT is towards a full and real time integration of purchasing processes, which is inhibited by current differences in buying specifications, product recognition codes, payment systems, shipping and delivery status. This process can be automated and an increasingly tight collaboration will be possible in the near future. Hence, it will be increasingly possible to "build" a company owning supply chain rather than depending on expensive "turn-key" OEMs.

#2: In a survey, measuring the maturity or the extent to which purchasing function contributes to the value creation, the applied metrics themselves of measuring were less developed (Cavinato 1999). This leads to opportunities in applying, for example, SCOR metrics in conjunction with the finance and accounting department. The literature emphasises the importance of collaboration and information exchange within the supply chain but no framework or methodology. Considering, for example, the SCOR framework and assuming an utilisation by all involved partners within a collaboration only a pictographic link is provided between the companies' source and the suppliers' deliver function but very little information is available on the level 2 and 3 process attributes to be exposed to suppliers or customers. Likewise, this is valid for the transfer on 'relevant' primary customer data to core partners. In essence, SCOR claims to provide supply chain methodology but does not enhance the prospects for inter-company collaboration while focussing primarily on the own company. Future research could provide ideas on the actual metrics that should be provided by customers and suppliers to achieve a true "information chain".

#3: Many studies reported a disappointing take up of electronic procurement in industry (Quayle 2003). New technologies are accepted by industry when (a) more income is generated or (b) internal process costs are reduced. This is certainly true for the sales side of a company manifested by the huge amount of online shops emerging in the recent past. Another driver is the pressure by large customers applying an approach "use or lose" - Use our e-procurement solution or lose our business. Hence, a question for further research can be how to provide cheap and easy-to-use information technology for automated data exchange for SMEs. An essential part of supply chain management is to streamline business processes across enterprise borders. Therefore, very complex frameworks such as ebXML or RosettaNet are available. From a manufacturing SMEs point of view, a demand forecast (sales side) and WIP (Work in Progress) information are essential. Additionally, do SMEs really need more than information datasets related to item, price, delivery, invoice for a start and demand forecast / WIP for advanced purposes? To date, there was no implementation framework for SMEs found in literature providing an approach to e-enable these five basic information requirements.

#4: Most of the available purchasing research literature maintains a positive association with the subject leading for many SMEs to an overestimation of importance. It has been contended many times that purchasing has become strategic and that the role of purchasing has become more important. Despite the seemingly optimistic results from much of the academic community, there appears to be very little interest in industry. In reality within SMEs, the purchasing functions are an administrative part of the organisation. This is clearly undervalued considering the potential of state of the art purchasing. Today's business environment of SMEs is characterised by globalisation, mass customisation, increased outsourcing and supply chain competition. This has an effect on the purchasing function predominately concerning qualification and knowledge. This will neither be achievable by 'ordinary' staff in purchasing departments, nor through the employment of a highly-qualified individual, who would be too expensive for many SMEs. Owners and senior management have to cope with these changes and acquire the required additional knowledge in areas such as e-business, SCM, BPR but also market knowledge that was previously domain of procurement staff. Hence, the procurement function has to be "distributed" within the company. Literature reporting requirements for future knowledge picture a highly skilled purchasing professional. Combined this leads to the thought that procurement functions and processes should be categorised like bought-in items. An ABC analysis could structure the purchasing function into:

- A-tasks: negotiating frame contracts, material replacements, outsourcing cost scenarios.
- B-tasks: RFQ specifications, metrics data mining and specification for reports, supplier management, market scanning;
- C-tasks: repetitive orders, monitoring, controlling;

The clarification of different levels of complexity within the purchasing function could lead to an increased acceptance across the company, as an increasing number of staff from other departments would be actively involved. The division of tasks will cascade the purchasing function top-down but inherently guarantee the necessary top management involvement.

REFERENCES

Aaltio-Marjosola, I. and Virolainen, V. (2003). The Role of Leadership in Partnering Networks *Global Purchasing and Supply Chain Strategies.* www.touchbriefings.com/pdf/976/05.pdf (Accessed 10/2007)

Abdul-Nour, G., Drolet, J. and Lambert, S. (1999). Mixed production, flexibility and SME. *Computers & Industrial Engineering, Proceedings of the 24th international conference on computers and industrial engineering. ISSN: 0360 -8352.* Vol. 37, No. 1-2, pp. 429-432.

Akacum, A. and Dale, B.G. (1995). Supplier partnering: Case study experiences. *International Journal of Purchasing and Materials Management. ISSN 1055-6001.* No. Winter, pp. 38-44.

Al-Mashari, M. (2002). Enterprise resource planning (ERP) systems: a research agenda. *Industrial Management & Data Systems. ISSN : 0263-5577.* Vol. 102, No. 3, pp. 165 - 170.

Allen, R.G. (2003). Best Practices e-Procurement. *Global Purchasing and Supply Chain Strategies.* www.touchbriefings.com/cdps/cditem.cfm?nid=24&cid=9 (Accessed 12/2003)

Alloway, R. (1977). Research and Thesis Writing Using Comparative Cases (cited in Gummeson 2000). Doctoral Thesis, International Business, Stockholm.

Alshawi, S., Themistocleous, M. and Almadani R. (2004). Integrating Diverse ERP Systems: A Case Study. *The Journal of Enterprise Information Management. ISSN 1741-0398.* Vol. 17, No. 6, pp. 454-462.

Alyesworth, M.M. (2003). Purchasing consortia in the public sector: models and methods for success. *Institute for Supply Management.* 88th Annual International Conference Proceedings - 2003 - Nashville, TN

AMR Research (2004). AMR Benchmark Analytix SCM Initial Assessment. http://www.amrresearch.com/tools/bmx/bmxsurvey.asp

Anand, K.S. and Ravi, A., . (2003). Group buying on the Web: A comparison of price-discovery mechanisms. *Management Sience. ISSN: 0025-1909.* Vol. 49, No. 11, pp. 1546-1562.

ANSI (2005). Quality Definition. *American National Standards Institute.*

Ansoff, I., Declerck, R. and Hayes, R. (1976). From strategic planning to strategic management. ISBN: 0471032239. New York. *Wiley.*

Archer, N. and Yuan, Y. (2000). Managing business-to-business relationships throughout the e-commerce procurement life cycle. *Internet Research: Electronic Networking Applications and Policy. ISSN 1066-2243.* Vol. 10, No. 5, pp. 385 - 395.

Armoutis, N. and Bal, J. (2003). E-Business through Competence Profiling. *e-Challenges 2003.* Barcelona

Arnold, U. (1997). Beschaffungsmanagement. Stuttgart. *Schaeffer-Poeschel.*

Arnold, U. (2000). New dimensions of outsourcing: a combination of transaction cost economics and the core competencies concept. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 6, No. 1, pp. 23-29.

Arnold, U. (2000). New dimensions of outsourcing: a combination of transaction cost economics and the core competencies concept. *European Journal of Purchasing and Supply Management.* Vol. 6, No. 1, pp. 23-29.

Attaran, M. (2001). The coming age of online procurement. *Industrial Management & Data Systems. ISSN : 0263-5577.* Vol. 101, No. 4, pp. 177-80.

Bailey, J. and Bakos, Y. (1997). An Exploratory Study of the Emerging Role of Electronic Intermediaries. *International Journal of Electronic Commerce. ISSN: 1086-4415.* Vol. 1, No. 3, pp. 7-20.

Bakos, Y. and Brynjolfsson, E. (1993). From Vendors to Partners: Information Technology and Incomplete Contracts in Buyer-Supplier Relationships. *Journal of Organizational Computing & Electronic Commerce. ISSN 1091-9392.* Vol. 3, No. 3, pp. 301-328.

Barnes, D., Hinton, M. and Mieczkowska, S. (2003). Competitive advantage through e-operations. *Total Quality Management & Business Excellence. ISSN: 1478-3363.* Vol. 14, No. 6, pp. 659-676.

Barnes, D., Hinton, M. and Mieczkowska, S. (2004). Avoiding the fate of the dotbombs: lessons from three surviving dotcom start-ups *Journal of Small Business and Enterprise Development. ISSN : 1462-6004.* Vol. 11, No. 3, pp. 329-337.

BarNir, A. and Smith, K.A. (2002). Interfirm Alliances in the Small Business: The Role of Social Networks. *Journal of Small Business Management. ISSN 0047-2778.* Vol. 40, No. 3, pp. 219–232.

Bartezzaghi, E. and Ronchi, S. (2003). Internet supporting the procurement process: lessons from four case studies. *Integrated Manufacturing Systems. ISSN 0951-5240.* Vol. 14, No. 8, pp. 632-641.

Bartezzaghi, E., Ronchi, S., (2004). A portfolio approach in the e-purchasing of materials. *Journal of Purchasing and Supply Management. ISSN 1478-4092.* Vol. 10, No. 3, pp. 117-126.

Batenburg, R. (2007). E-procurement adoption by European firms: A quantitative analysis *Journal of Purchasing and Supply Management. ISSN 1478-4092.* Vol. 13, No. 3, pp. 182-192.

Behrman, J.N. and Levin, R.I. (1984). Are business schools doing their job? *Harvard Business Review. ISSN: 0017-8012.* Vol. 62, No. 1, pp. 140-147.

Benbasat, I., Goldstein, D.K. and Mead, M. (1987). The Case Research Strategy in Studies of Information Systems *MIS Quarterly. ISSN: 0276-7783.* Vol. 11, No. 3, pp. 369-386.

Bessant, J., Francis, D., Meredith, S., Kaplinsky, R. and Brown, S. (2003). Developing manufacturing agility in SMEs. *International Journal of Manufacturing Technology and Management (IJMTM). ISSN 1368-2148.* Vol. 22, No. 1-2, pp. 28-54.

Birou, L., Fawcett, S.E. and Magnan, G.M. (1997). Integrating product life cycle and purchasing strategies. *International Journal of Purchasing and Materials Management. ISSN 1055-6001.* Vol. 33, No. 1, pp. 23-32.

Bititci, U., Turner, T., Mackay, D., Kearney, D., Parung, J. and Walters, D. (2007). Managing synergy in collaborative enterprises *Production Planning and Control. ISSN 0953-7287.* Vol. 18, No. 6, pp. 454-465.

Bititci, U.S., Martinez, V., Albores, P. and Mendibil, K. (2003). Creating and sustaining competitive advantage in collaborative systems: the what and the how. *Production Planning and Control. ISSN 0953-7287.* Vol. 14, No. 5, pp. 410-424.

Boer, L., Harink, J. and Heijboer, G. (2002). A Conceptual Model of Assessing the Impact of Electronic Procurement. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 8, No. 1, pp. 25-33.

Bolstroff, P. (2002). Everything's according to plan. *Supply Chain Technology News.* pp. www.totalsupplychain.com

Bolstroff, P. (2003). Measuring the impact of supply chain performance. *Logistics Today. ISSN: 1547-1438.* Vol. December, pp. 6-11. www.scelimited.com/sitebuildercontent/sitebuilderfiles/measuringtheimpactofsupplychainperformance.pdf (Accessed 05/2005)

Bolstroff, P. and Rosenbaum, R. (2003). Supply chain excellence - a handbook for dramatic improvement using the SCOR model. ISBN:0814407307. *Amacom.*

Bourner, T. and Simpson, P. (2005). Practitioner-centred research and the PhD. *Action Learning: Research and Practice. ISSN 1476-7333.* Vol. 2, pp. 133-52.

Bourner, T., Simpson, P. (2005). Practitioner-centred research and the PhD. *Action Learning: Research and Practice.* Vol. 2, pp. 133-52.

Bragila, M., Carmignani, G. and Zammori, Z. (2006). A new value stream mapping approach for complex production systems. *International Journal of Production Research. ISSN 0020-7543.* Vol. 44, No. 18-19, pp. 3929-3952.

Brandel, M. (1997). The Other EDI. www2.computerworld.com/Emmerce/All/harb (Accessed 05/2000)

Bretzke, W.R. (2003). Supply chain event management - Bridging the gap between planning and realisation. *Global Purchasing and Supply Chain Strategies.* http://www.touchbriefings.com/download.cfm?fileID=815&action=downloadFile&user_id=14795

Breu, K. and Hemingway, C. (2005). Researcher-Practitioner Partnering in Industry-Funded Participatory Action Research. *Systemic Practice and Action Research. ISSN: 1094-429X.* Vol. 18, No. 5, pp. 437-455.

Brousseau, C. (2005). Tomorrow's procurement tools. *ASCET - Achieving Supply Chain Excellence through Technology.* Vol. 7, http://www.ascet.com

Bryman, A. and Bell, E. (2003). Business research methods. ISBN: 0199284989. New York. *Oxford University Press Oxford.*

Bullinger, H.-J., Kuehner, M. and van Hoof, A. (2002). Analysing supply chain performance using a balanced measurement method *International Journal of Production Research. ISSN 0020-7543.* Vol. 40, No. 15, pp. 3533-3543.

Cancro, P.J. and McGinnis, M.A. (2003). Financial accounting basics for purchasing and supply professionals. *Institute for Supply Management.* 88th Annual International Conference Proceedings - 2003 - Nashville, TN

Caniels, M.C.J. and Gelderman, C.J. (2005). Purchasing strategies in the Kraljic matrix - A power dependence perspective. *Journal of Purchasing and Supply Management. ISSN 1478-4092.* Vol. 11, pp. 141-155.

Caniels, M.C.J., Gelderman, C.J., (2005). Purchasing strategies in the Kraljic matrix - A power dependence perspective. *Journal of Purchasing and Supply Management.* Vol. 11, pp. 141-155.

Carr, A.S. and Smeltzer, L.R. (1999). The relationship of strategic purchasing to supply chain management. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 5, pp. 43-51.

Carr, G.N. (2003). IT doesn't matter. *Harvard Business Review.* Vol. May, pp. 41-49.

Carter, J.R. and Miller, J.G. (1989). The Impact of Alternative Vendor/Buyer Communication Structures on the Quality of Purchased Materials. *Decision Sciences. ISSN 0011-7315.* Vol. 40, No. 4, pp. 759-76.

Carter, J.R., Narasimhan, R., (1996). Is purchasing really strategic? *International Journal of Purchasing and Materials Management. ISSN 1055-6001.* Vol. Winter, pp. 20-28.

Carter, P.L., Carter, J.R., Monczka, R.M., Slaight, T.H. and Swan, A.J. (2000). The future of purchasing and supply: A ten-year forecast. *Journal of Supply Chain Management. ISSN 1523-2409.* Vol. 36, No. 1, pp. 14-26.

Carter, P.L., Carter, J.R., Monczka, R.M., Slaight, T.H., Swan, A.J., (2000). The future of purchasing and supply: A ten-year forecast. *Jounal of Supply Chain Management.* Vol. 36, No. 1, pp. 14-26.

Carter, P.L. and Monczka, R.M. (2005). Strategic Performance Measurement for Purchasing and Supply, CAPS: Center for Strategic Supply Research. www.capsresearch.org/publications/pdfs-public/carterp2005es.pdf (Accessed 01/2006)

Cavinato, J.L. (1999). Fitting purchasing to the five stages of strategic management. *European Journal of Purchasing and Supply Management.* Vol. 5, No. 2, pp. 75-83.

Cavinato, J.L. (1999). Fitting purchasing to the five stages of strategic management. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 5, No. 2, pp. 75-83.

CBI & KPMG Consulting (2002). Reality bites - The second annual report an e-business in the UK. London. *CBI.*

Chalmers, A.F. (1978). What is this thing called science? ISBN: 0872204529. Milton Keynes. *Open University Press.*

Chapman, P., James-Moore, M., Szczygiel, M. and Thompson, D. (2000). Building Internet capabilities in SMEs. *Logistics Information Management. ISSN 0957-6053.* Vol. 13, No. 6, pp. 353 - 361.

Chaston, I., Badger, B. and Sadler-Smith, E. (1999). Organisational learning: research issues and application in SME sector firms *International Journal of Entrepreneurial Behaviour & Research. ISSN 1355-2554.* Vol. 5, No. 4, pp. 191 - 203.

Chen, I.J. and Paulraj, A. (2004). Understanding supply chain anagement: critical research and a theoretical framework *International Journal of Production Research. ISSN 0020-7543.* Vol. 42, No. 1, pp. 131-163.

Chen, I.J., Paulraj, A. and Lado, A.A. (2004). Strategic purchasing, supply management and firm performance. *Journal of Operations Management. ISSN 0272-6963.* Vol. 22, No. 5, pp. 505–523.

Chen, W.S. and Hirschheim, R. (2004). A paradigmatic and methodological examination of information systems research from 1991 to 2001. *Information Systems Journal. ISSN 1350-1917.* Vol. 14, No. 3, pp. 197-235.

Chesher, M. and Kaura, R. (1998). Electronic commerce and business communications. ISBN: 3540199306. Berlin. *Springer Verlag.*

Christiansen, P.E. and Maltz, A. (2002). Becoming an "Interesting" Customer: Procurement Strategies for Buyers without Leverage. *International Journal of Logistics Research and Applications. ISSN : 1367-5567.* Vol. 5, No. 2, pp. 177 - 195.

Christopher, M. (2000). The Agile Supply Chain: Competing in Volatile Markets. *Industrial Marketing Management.* Vol. 29, No. 1, pp. 37-44.

Christopher, M. (2000). The Agile Supply Chain: Competing in Volatile Markets. *Industrial Marketing Management. ISSN 0019-8501.* Vol. 29, No. 1, pp. 37-44.

CIPS (2003). Purchasing and Supply management collaboration between organisations. *The Chartered Institute of Purchasing and Supply Management.* www.cips.org

Claver, E., Gonzalez, R. and Llopis, J. (2000). An analysis of research in information systems (1981-1997) *Information & Management. ISSN: 0378-7206.* Vol. 37, No. 4, pp. 181-195.

COED (2005). Concise Oxford English Dictionary Version 11. *Oxford University Press.*

Collins (2000). English Dictionary. *Harper Collins Publishers.*

Cooper, R. (2007). Seven "principles" of innovation: A lack of focus *Strategic Direction. ISSN 0258-0543.* Vol. 23, No. 1, pp. 38-40.

Coughlan, P. and Coghlan, D. (2002). Action research for operations management *International Journal of Operations & Production Management. ISSN 0144-3577.* Vol. 22, No. 2, pp. 220-240.

Coughlan, P., Coghlan, D., (2002). Action research for operations management *International Journal of Operations & Production Management* Vol. 22, No. 2, pp. 220-240.

Cousins, P. (1999). Supply base rationalisation: myth or reality? *European Journal of Purchasing & Materials Management.* No. 5, pp. 143-155.

Cousins, P.D. (2005). The alignment of appropriate firm and supply strategies for competitive advantage. *International Journal of Operations and Production Management.* Vol. 25, No. 5, pp. 403-428.

Cox, A. (1996). Relational competence and strategic procurement management. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 2, No. 1, pp. 57-70.

Creswell, J. (1998). Qualitative inquiry and research design: Choosing among five traditions. Thousand Oaks, CA. *Sage Publications.*

Croom, S.R. (2000). The impact of Web-based procurement on the management of operating ressources supply. *Journal of Supply Chain Management. ISSN 1523-2409.* Vol. 36, No. 1, pp. 4-19.

Crosby, P.B. (1979). Quality is free : the art of making quality certain. London. *McGraw-Hill.*

CSCMP (2003). Council of Supply Chain Management Professionals: Supply chain visions logistics terms and glossary. www.cscmp.org/Downloads/Resources/glossary03.pdf

Da Silveira, G., Borenstein, G. and Fogliatto, F.S. (2001). Mass customization: Literature review and research directions. *International Journal of Production Economics. ISSN 0925-5273.* Vol. 72, No. 1, pp. 1-13.

Dai, Q. and Kauffman, R.J. (2002). Business Models for Internet-Based B2B Electronic Markets. *International Journal of Electronic Commerce. ISSN: 1086-4415.* Vol. 6, No. 4, pp. 41-72.

Danilovic, M. and Winroth, M. (2005). A tentative framework for analyzing integration in collaborative manufacturing network settings: a case study. *Journal of Engineering and Technology Management.* Vol. 22, No. 1-2, pp. 141-158.

Das, A. and Handfield, R.B. (1997). A meta-analysis of doctoral dissertations in purchasing. *Journal of Operations Management. ISSN 0272-6963.* Vol. 15, No. 2, pp. 101-121.

Das, T.K. and Teng, B.-S. (1998). Between Trust and Control: Developing Confidence in Partner Cooperation in Alliances. *Academy of Management Review. ISSN: 03637425.* Vol. 23, No. 3, pp. 491-512.

Davenport, T.H. and Brooks, J.D. (2004). Enterprise systems and the supply chain. *Journal of Enterprise Information Management.* Vol. 17, No. 1, pp. 8-19.

Davila, A., Gupta, M. and Palmer, R. (2003). Moving Procurement Systems to the Internet - the Adoption and Use of E-Procurement Models. *European Management Journal. ISSN: 0263-2373.* Vol. 21, No. 1, pp. 11-23.

Davison, R.M. (1998). Title An action research perspective of group support systems : how to improve meetings in Hong Kong. Doctoral Thesis, City University of Hong Kong.

Davulcu, H., Kifer, M., Ramakrishnan, C.R. and Ramakrishnan, I.V. (1998). Logic based modeling and analysis of workflows. *ACM Symposium on Principles of Database Systems.*

Degraeve, Z., Roodhooft, F. and van Doveren, B. (2005). The use of total cost of ownership for strategic procurement: a company-wide management information system. *Journal ofthe Operational Research Society. ISSN: 0160-5682.* Vol. 56, No. 1, pp. 51-59.

DeRuntz, B.D. and Turner, R.M. (2003). Organizational Considerations for Advanced Manufacturing Technology [14. *The Journal of Technology Studies. ISSN: 1071-6084.* Vol. XXIX, No. 1, pp.

Dick, B. (1997). Approaching an Action Research Thesis: An Overview. *Action Research and Evaluation On Line (AREOL).* http:\\www.scu.edu.au/schools/gcm/ar/arp/guide.html.

Dictionary (2007). www.dictionary.com (Accessed 01/2008).

Do, D., Svedberg, S. and Karlsson, J. (2006). Characteristics of SME Outsourcing. *Jönköping International Business School.* Jönköping. www.diva-portal.org/hj/abstract.xsql?dbid=481 (Accessed 01/2008)

Dolmetsch, R. (1999). Desktop Purchasing - IP-Netzwerkapplicationen in der Beschaffung. Doctoral thesis, University of St. Gallen, Swiss.

Dolmetsch, R. (1999). Desktop Purchasing - IP network applications in purchasing (in German: Desktop Purchasing - IP-Netzwerkapplicationen in der Beschaffung). Doctoral thesis, University of St. Gallen, Swiss.

Doucette, W.R. (1997). Influences on Member Commitment to Group Purchasing Organisations. *Journal of Business Research.* Vol. 40, No. 3, pp. 183-189.

Drew, S. (2003). Strategic Uses of E-Commerce by SMEs in the East of England *European Management Journal. ISSN: 0263-2373.* Vol. 21, No. 1, pp. 79-88.

DTI (1998). Technology Foresight Reports. London. *Department of Trade and Industry.*

Dubois, A. and Pedersen, A. (2002). Why relationships do not fit into purchasing portfolio models - a comparison between the portfolio and industrial network approaches. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 8, No. 1, pp. 35-42.

Dyer, J.H. (2000). Collaborative Advantage: Winning through extended enterprise networks. London. *Oxford University Press.*

ebXML (2004). Electronic Business using eXtensible Markup Language. www.ebxml.org (Accessed 10/2005)

Eden, C. and Huxham, C. (1996). Action Research for Management Research. *British Journal of Management. ISSN 1045-3172.* Vol. 7, No. 1, pp. 75-86.

Eden, C., Huxham, C., (1996). Action Research for Management Research *British Journal of Management.* Vol. 7, No. 1, pp. 75-86.

El Sawy, O. (2001). Identifying Structural Models of B2B Procurement Exchanges. *Final Technical Report, Marshall School of Business, University of Southern California.*

Ellram, L.M., Billington, C., (2005). Stop misallocating purchasing ressouces. *Institute for Supply Management.* 90th Annual International Conference Proceedings - 2005 - San Antonio, TX

Ellram, L.M., Zsidisin, G.A., Siferd, S.P. and Stanly, M.J. (2002). The impact of purchasing and supply management activities on corporate success. *Journal of Supply Chain Management. ISSN 0258-0543.* Vol. 38, No. 1, pp. 4-18.

Ellram, L.M., Zsidisin, G.A. (2002). Factors that drive purchasing and supply management's use of information technology. *IEEE Transactions on Engineering Management. ISSN: 00189391.* Vol. 49, No. 3, pp. 269- 281.

Elting, A. (2002). Normierter Handel. *ix Special XML.* Vol. 1, pp. 114-117. www.heise.de/ix

Erridge, A., Fee, R. and McIlroy, J. (2001). Best practice procurement. ISBN: 0566083663. *Gower Publishing Ltd.*

Eschenbaecher, J. and Zwegers, A. (2002). Collaboration in value creating Networks: the concept of collaborative commerce. *Eighth International Conference on Advances in Production Management Systems "Collaborative Systems for Production Management"*. Eindhoven, Netherlands

Eßig, M. (2000). Purchasing consortia as symbiotic relationships: developing the concept of "consortium sourcing". *European Journal of Purchasing and Supply Management.* Vol. 6, No. 1, pp. 13-22.

Essig, M. (1999). Cooperative Sourcing. Doctoral thesis, Frankfurt a.M. Peter Lang.

Essig, M. (2000). Purchasing consortia as symbiotic relationships: developing the concept of "consortium sourcing". *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 6, No. 1, pp. 13-22.

European Commission (2003). The new SME definition. http://europa.eu.int/comm/enterprise/enterprise_policy/sme_definition/index_en.htm

EUROSTAT (2005). The EU-15's New Economy - A statistical portrait. http://epp.eurostat.cec.eu.int/cache/ITY_OFFPUB/KS-AV-05-001/EN/KS-AV-05-001-EN-TOC.PDF

Evans, P. and Wurster, T. (1997). Strategy and the New Economics of Information. *Harvard Business Review. ISSN: 0017-8012.* Vol. September-October, pp. 75.

Eyholzer, K. (2002). Einsatzpotentiale und Auswirkungen von E-Procurement-Lösungen. Doctoral thesis, University of Bern, Swiss.

Eyholzer, K., Hunzinger, D., (2000). The use of the Internet in Procurement: An empirical analysis. *Proceedinggs ot the 8th European Conference of Information Systems*. Vienna

Favilla, J. and Fearne, A. (2005). Supply chain software implementations: getting it right. *Supply Chain Management: An International Journal. ISSN 1359-8546.* Vol. 10, No. 4, pp. 241-243.

Fornasiero, R. and Zangiacomi, A. (2006). Setting up e-platforms for collaboration in SME contexts. *International Journal of Business Performance Management. ISSN 1368-4892.* Vol. 8, No. 11, pp. 77-92.

Galliers, R. (1992). Information Systems Research: Issues, Methods, and Practical Guidelines. *Blackwell Scientific Publications, Oxford.*

Gebauer, J., Beam, C. and Segev, A. (1998). Impact of the Internet on Procurement. *Acquisition Review Quarterly. ISSN:1087-3112.* Vol. 5, No. 2, pp. 167-184.

Gebauer, J. and Segev, A. (2001). Changing Shapes of Supply Chains – How the Internet Could Lead to a More Integrated Procurement Function. *Working Paper 01-WP-1041, Fisher Center for Information Technology and Marketplace Transformation, Berkeley, Haas School of Business, University of California.*

Gebauer, J., Segev, A., (1998). Assessing internet-based procurement to support the virtual enterprise. *Electronic Journal of Organizational Virtualness. ISSN: 14229331.* Vol. 2, No. 3, pp. 30-43.

Gelderman, C.J. and van Weele, A.J. (2002). Strategic direction through purchasing portfolio management: A case study. *Journal of Supply Chain Management. ISSN 1523-2409.* Vol. Spring, pp. 30-37.

Gelderman, C.J. and van Weele, A.J. (2005). Purchasing portfolio models: A critique and update. *Journal of Supply Chain Management. ISSN 0258-0543.* Vol. Summer 2005, pp. 19-28.

Gerwin, D. (1987). An agenda for research on flexibility of manufacturing processes. *International Journal of Operations and Production Management.* Vol. 7, No. 1, pp. 38-49.

Gilmore, A., Carson, D. and Grant, K. (2001). SME marketing in practice. *Marketing Intelligence & Planning. ISSN 0263-4503.* Vol. 19, No. 1, pp. 6 - 11.

Gilmour, P. (1999). Benchmarking supply chain operations *International Journal of Physical Distribution and Logistics Management. ISSN: 0960-0035* Vol. 29, No. 4, pp. 259 - 266.

Ginsberg, B. (2002). Measuring the Success of Collaboration across the Virtual Supply Chain Through Performance Measurement Systems and Benchmarking. *Supply Chain World — South East Asia May 21, 2002.* Singapore

Giunipero, L. and Handfield, R.B. (2004). Purchasing Education and Training II, Center forAdvanced Purchasing Studies, CAPS: Center for Strategic Supply Research. www.capsresearch.org/publications/pdfs-public/giunipero2004es.pdf (Accessed 10/2005)

Glaser, B.G. and Strauss, A.L. (1968). The discovery of grounded theory: strategies for qualitative research. ISBN: 0297763180. London. *Weidenfeld and Nicolson.*

Granot, D. and Sosic, G. (2005). Formation of Alliances in Internet-Based Supply Exchanges. *Management Science. ISSN 0025-1909.* Vol. 51, No. 1, pp. 92-105.

Grant, R.M. (1991). The resource-based theory of competitive advantage: implications for strategy formulation. *California Management Review.* Vol. Spring 1991, pp. 114-135.

Gray, K. (2003). Consortia, buying groups, and trends in demand aggregation. *Institute for Supply Management.* 88th Annual International Conference Proceedings - 2003 - Nashville, TN

Grieger, M. (2004). An empirical study of business processes across Internet-based electronic marketplaces. *Business Process Management Journal.* Vol. 10, No. 1, pp. 80-10.

Guba, E.G. and Lincoln, Y.S. (1989). Fourth Generation Evaluation. ISBN: 0803932359. Newbury Park, CA. *Sage.*

Gulati, R. (1995). Social Structure and Alliance Formation Patterns: A Longitudinal Analysis. *Administrative Science Quarterly. ISSN: 0001-8392.* Vol. 40, No. 4, pp. 619-652.

Gulati, R., Nohria, N. and Zaheer, A. (2000). Strategic networks. *Strategic Management Journal. ISSN: 0143-2095.* Vol. 21, pp. 203-215.

Gummesson, E. (2000). Qualitative Methods in Management Research. Thousand Oaks, Carlifornia. *Sage Publications.*

Gummesson, E. (2000). Qualitative Methods in Management Research. ISBN: 0761920145. Thousand Oaks, Carlifornia. *Sage Publications.*

Gushee, E.T. and Boffey, L.F. (1928). Scientific Purchasing. ASIN: B00086LAR8. New York. *McGraw-Hill.*

Hamel, G. and Prahalad, C.K. (1994). Competing for the future. ISBN: 0875844162. Boston. *Harvard Business School Press.*

Handfield, R.B., Ragatz, G.L., Petersen, K.J. and Monczka, R.M. (1999). Involving suppliers in new product development. *California Management Review. ISSN: 0008-1256.* Vol. 42, No. 1, pp. 59-82.

Handfield, R.B. and Straight, S.L. (2004). How mature is your supply chain? The SCRD Capability Maturity Model. *Institute for Supply Management.* 89th Annual International Conference Proceedings - 2004 - Philadelphia, PA

Hanman, S. (1997). Benchmarking Your Firm's Performance With Best Practice. *The International Journal of Logistics Management. ISSN: 0957-4093.* Vol. 8, No. 2, pp. 1 - 18.

Harland, C.M., Lamming, R.C. and Cousins, P.D. (1999). Developing the concept of supply strategy *International Journal of Operations & Production Management. ISSN 0144-3577.* Vol. 19, No. 7, pp. 650 - 674.

Harrison, G.W. and List, J.A. (2004). Field Experiments. *Journal of Economic Literature.* Vol. 42, No. 4, pp. 1009-1055.

Heijboer, G.J. (2003). Quantitative analysis of strategic and tactical purchasing decisions. Doctoral thesis, Enschede. Twente University.

Hendrick, T.E. (1997). Purchasing Consortiums: Horizontal Alliances among Firms Buying Common Goods and Services What? Who? Why? How? *Center for Advanced Purchasing Studies.*

Heshmati, A. (2003). Productivity Growth, Efficiency and Outsourcing in Manufacturing and Service Industries. *Journal of Economic Surveys.* Vol. 17, No. 1, pp. 79–112.

Hicks, C., McGovern, T. and Earl C.F. (2000). Supply chain management: A strategic issue in engineer to order manufacturing. *International Journal of Production Economics. ISSN 0925-5273.* Vol. 65, No. 2, pp. 179-190.

Hirschheim, R.A. (1992). Information systems epistemology: An historical perspective. In Information Systems Research: Issues, Methods and Practical Guidelines (Galliers, R.D. Ed.). ISBN: 0632028645. Oxford. *Blackwell, UK.*

Hirschman, E. (1986). Humanistic enquiry in marketing research: philosophy, method and criteria. *Journal of Marketing Research. ISSN: 0022-2437.* Vol. 23, No. 3, pp. 237-249.

Hoepfl, M.C. (1997). Choosing qualitative research: A primer for technology education researchers. *Journal of Technology Education. ISSN: 10451064.* Vol. 9, No. 1, pp. 47-63.

Hoffmann, W.H. and Schlosser, R. (2001). Success Factors of Strategic Alliances in Small and Medium-Sized Enterprises - an Empirical Survey. *Long Range Planning. ISSN 0024-6301.* Vol. 34, No. 3, pp. 357–381.

Holloway, I. and Wheeler, S. (1995). Ethical issues in qualitative nursing research. *Nursing Ethics. ISSN 0969-7330.* Vol. 2, No. 3, pp. 223-232.

Hoover (2004). Company, industry and market intelligence. http://www.hoovers.com/freeuk/

Hoovers (2004). Company, industry and market intelligence. www.hoovers.com/freeuk/ (Accessed 12/2004)

Huan, S.H., Sheoran, S.K. and Wang, G. (2004). A review and analysis of supply chain operations reference (SCOR) model. *Supply Chain Management: An International Journal. ISSN 1359-8546.* Vol. 9, No. 1, pp. 23-29.

Huber, B., Sweeny, E. and Smyth, A. (2004). Purchasing consortia and electronic markets - a procurement direction in integrated supply chain management. *Electronic Markets and Supply Chains.* Vol. 14, No. 4, pp. 284-294.

Huber, B.L. (2002). Buy! Buy! Buy! - Assessing collaborative procurement. *Logistics Solutions.* Vol. 29, No. 2, pp. 29-32.

Hughes, E.J., Crichton, G., (2002). Interim findings of the research into: Strategies for purchasing transformation 2002-2005. Institute of International Purchasing. Bordeaux Business School. http://www.futurepurchasing.com/survey.html

Hughes, E.J., Crichton, G., Day, M., Vammen, S., (2003). Managing the waves of change - applying a holistic framework for purchasing change management. *Revue Internationale de l'Achat. ISSN: 0292-2096.* Vol. 23, No. 1, pp. 3-12.

Hughes, E.J., Day, M. and Hughes, D.W. (2004). Connecting purchasing and supplier strategies to organisational strategy: an analysis of current trends in purchasing practice. IPSERA.

Hunt, S.D. (1976). Marketing theory : conceptual foundations of research in marketing. Columbus, Ohio.

Hwang, Y. (2006). The practices of integrating manufacturing execution systems and Six Sigma methodology *The International Journal of Advanced Manufacturing Technology. ISSN: 0268-3768.* Vol. 31, No. 1-2, pp. 145-154.

IADET (2004). Competence Profiling Methodology Software. *Institute of Agility and Digital Enterprise Techlology*

Jeeva, A.S. (2004). Procurement dimensions in the Australian manufacturing sector: Flexibility issues in a supply chain perspective. *School of Management.* Perth. Curtin University of Technology.

Johanson, J. and Mattson, L. (1987). Interorganizational relations in industrial systems: a network approach compared with the transaction-cost approach. *International Studies of Management and Organization. ISSN: 0020-8825.* Vol. 17, No. 1, pp. 34–48.

Johnston, D.A., Wade, M. and McClean, R. (2007). Does eBusiness Matter to SMEs?: A Comparison of the Financial Impacts of Internet Business Solutions on European and North American SMEs. *Journal of Small Business Management. ISSN 0047-2778.* Vol. 45, No. 3, pp. 354-361.

Kamann, D.-J.F. (1999). Extra dimensions to portfolio analysis, www.GripOnPurchasing.com (Accessed 03/2001).

Kamann, D.-J.F. (2003). The Strategic Value of Proper Purchasing. *Institute for Supply Management.*

Kanter, R.M. (1994). Collaborative advantage: The art of alliances. *Harvard Business Review.* Vol. 72, No. 4, pp. 96-109.

Kanter, R.M. (1994). Collaborative advantage: The art of alliances. *Harvard Business Review. ISSN: 0017-8012.* Vol. 72, No. 4, pp. 96-109.

Kaplan, S. and Sawhney, M. (2000). E-hubs: The New B2B Marketplaces. *Harvard Business Review. ISSN: 0017-8012.* Vol. 78, No. 3, pp. 97-103.

Kaplinsky, R. and Morris, M. (2001). A Handbook for Value Chain Research. www.ids.ac.uk/ids/global/pdfs/VchNov01.pdf (Accessed 12/2001)

Kasi, V. (2005). Systematic Assessment of SCOR for Modeling Supply Chains. *Proceedings of the 38th Hawaii International Conference on System Sciences.*

Katzy, B.R. and Schuh, G. (1997). The Virtual Enterprise, in: Molina, A., Sanchez, J. M., Kusiak, A. (eds.), Handbook of Life Cycle Engineering: Concepts, Methods and Tools. ISBN: 0412812509. New York. *Chapman & Hall.* http://portal.cetim.org/p_1_res-documents.php

Kauffman, R.J. (2002). Supply management: what's in a name? Or, do we know who we are? *Journal of Supply Chain Management.* Vol. 38, No. 4, pp. 46-50.

Kauffman, R.J. and Wang, B. (2001). New Buyers' Arrival Under Dynamic Pricing Market Microstructure: The case of Group-Buying Discounts on the Internet. *Journal of Management Information Systems. ISSN: 0742-1222.* Vol. 18, No. 2, pp. 157-188.

Kauffman, R.J., Wang, B., (2001). New Buyers' Arrival Under Dynamic Pricing Market Microstructure: The case of Group-Buying Discounts on the Internet. *Jounal of Management Information Systems.* Vol. 18, No. 2, pp. 157-188.

Kemmis, S. and McTaggart, R. (1988). The Action Research Planner. ISBN: 0730005216. Geelong.

Keys, P. (1991). Operational research and systems; the systemic nature of operational research. ISBN: 0306436426. New York. *Plenum press.*

Knight, L., Harland, C., (2005). Managing Supply Networks: Orgainsational roles in network management. *European Management Journal.* Vol. 23, No. 3, pp. 281-292.

Knight, L. and Zheng, J. (2003). Review of the purchasing and supply profession. *University of Bath - School of Management - CRiSPS.* www.bath.ac.uk/crisps/projects/confederal_networks.html (Accessed 01/2004)

Knudsen, D. (2003). Improving procurement performance with e-business mechanisms, Doctoral thesis. *Department of Industrial Management and Logistics, Lund University*. Lund, Sweden.

Knudsen, D. (2003b). Improving procurement performance with e-business mechanisms, Doctoral thesis. *Department of Industrial Management and Logistics, Lund University*. Lund, Sweden.

Knudson, D. (2002). Uncovering the strategic domain of e-procurement. *IPSERA*. Enschede

Knudson, D. (2003). Aligning corporate strategy, procurement strategy and e-procurement tools. *International Journal of Physical Distribution and Logistics Management. ISSN: 0960-0035.* Vol. 33, No. 8, pp. 720-734.

Koch, R. (1998). The 80/20 Principle. ISBN: 0385491700. Doubleday. *Nicholas Brealey Publishing.*

Kock, N.F., McQueen, R.J. and Scott, J.L. (2000). Can action research be made more rigorous in a positivist sense? www.cis.temple.edu/~kock/public/jsit97/isarw6.htm (Accessed 06/2005)

Kornelius, L. (1999). Inter-organisational infrastructures for competitive advantage. Doctoral thesis, Eindhoven University of Technology.

Kraljic, P. (1983). Purchasing must become supply management. *Harvard Business Review.* Vol. 61, No. 5, pp. 109-117.

Kraljic, P. (1983). Purchasing must become supply management. *Harvard Business Review. ISSN: 0017-8012.* Vol. 61, No. 5, pp. 109-117.

Laing, A. and Cotton, S. (1997). Patterns of inter-organizational purchasing : Evolution of consortia-based purchasing amongst GP fundholders. *European Journal of Purchasing and Supply Management. ISSN: 0969-7012.* Vol. 3, No. 2, pp. 83-91.

Lambert, D.M., Garcia-Dastugue, S.J. and Croxton, K.L. (2005). An evaluation of process-oriented supply chain management frameworks. *Journal of Business Logistics.* Vol. 26, No. 1, pp. 25-51.

Lancioni, R.A. (2000). New development in supply chain management for the millennium. *Industrial Marketing Management.* Vol. 29, No. 1, pp. 1-6.

Lankford, W.M. and Parsa, F. (1999). Outsourcing: a primer *Management Decision. ISSN 0025-1747.* Vol. 37, No. 4, pp. 310 - 316.

Larson, P.D. and Halldorsson, A. (2002). What is SCM? And, Where is it? *Journal of Supply Chain Management. ISSN 0258-0543.* Vol. 38, No. 4, pp. 36-44.

Lee, J., Siau, K. and Hong, S. (2003). Enterprise integration with ERP and EAI *Communications of the ACM. ISSN: 0001-0782.* Vol. 46, No. 2, pp. 54 - 60.

Lehtinen, U. (2001). Changing Subcontracting: A Study on the Evolution of Supply Chains and Subcontractors, Doctoral thesis, Department of Industrial Engineering, University of Oulu, Finnland.

Levitt, S. and List, L. (2007). What Do Laboratory Experiments Tell Us About the Real World? *Journal of Economic Perspectives.* Vol. 21, No. 2, pp. 153-174.

Levy, M., Loebbecke, C. and Powell, P. (2001). SMEs, co-opetition and knowledge sharing: the IS role. *Global Co-Operation in the New Millennium, The 9th European Conference on Information Systems*. Bled, Slovenia, June 27-29,

Levy, M., Powell, P. and Yetton, P. (2001). SMEs: aligning IS and the strategic context. *Journal of Information Technology.* Vol. 16, No. 3, pp. 133-144.

Levy, M., Powell, P., (2003). Exploring SME Internet Adoption: towards a contingent model. *Electronic Markets. ISSN 1019-6781.* Vol. 13, No. 2, pp. 173-181.

Lewis, C., Roth, L. and White, A. (2001). Global Commerce InitiativeCollaborative Planning Forecasting and Replenishment (CPFR®)n-tier CPFR, Interim Report Update #4, Global Commerce Initiative. *VICS.* www.vics.org/apps/group_public/download.php/33/GCI_n-Tier_CPFR_Interim_Report_Update4.doc (Accessed 03/2003)

Lincoln, Y.S. and Guba, E.G. (1985). Naturalistic Enquiry. ISBN: 0803924313. Beverley Hills. *Sage.*

Lonergan, E. (2003). Introduction to supply and materials management. *The Chartered Institute of Purchasing and Supply.*

Lonergan, E. (2003). Introduction to supply and materials management. ISBN: 1861241267. *The Chartered Institute of Purchasing and Supply.*

Macie, K.E. (1995). The purchasing consortium - is it right for my company? *NAPM Annual International Conference.* Anaheim, California

MacManus, S. (2002). Understanding the Incremental Nature of E-Procurement Implementation at the State and Local Levels. *Journal of Public Procurement. ISSN: 1535-0118.* Vol. 2, No. 1, pp. 5-28.

Magretta, J. (2002). Why Business Models Matter. *Harvard Business Review. ISSN: 0017-8012.* Vol. 80, No. 5, pp. 86-93.

Mahler, E.G. and Singh, H. (2002). Sales and Operations Planning. www.supplychain.com/SCM_Fundamentals.asp (Accessed 12/2002)

Major, E., Ascha, D. and Cordey-Hayesb, M. (2001). Foresight as a core competence. *Futures. ISSN 0016-3287.* Vol. 33, No. 2, pp. 91-107.

Mangan, J., Lalwani, C. and Gardner, G. (2004). Combining quantitative and qualitative methodologies in logistics research. *International Journal of*

Physical Distribution and Logistics Management. ISSN: 0960-0035. Vol. 34, No. 7, pp. 565 - 578.

Maropoulos, P.G., Armoutis, N., Bramall, D., Lomas, C., Chapman, P. and Rogers, B. (2004). Agile design and manufacturing in collaborative networks for the defence industries. *IFAC 2004*.

Matchette, J.B. and Seikel, M.A. (2004). How to win friends and influence supply chain leaders. *Logistics Today. ISSN: 1547-1438.* Vol. December, www.logisticstoday.com/sNO/6828/iID/20900/LT/displayStory.asp (Accessed 12/2005)

Matile, P.Y. (2003). Re-Inventing Supply Chains - from the value chain to the value network, from communication to collaboration. *Global Purchasing and Supply Chain Strategies.* http://www.touchbriefings.com/download.cfm?fileID=818&action=downloadFile&user_id=14795

McCormack, K.P., Johnson, W.C. and Walker, W.T. (2003). Supply chain networks and business process orientation. ISBN: 1574443275. Boca Raton, Florida. *St. Lucie Press.*

McDonagh, J. and Coghlan, D. (2000). Sustaining the dilemma with IT-related change: the fortuitous role of academia. *Journal of European Industrial Training* Vol. 24, No. 5, pp. 297-304.

McGinnis, M.A. and Cancro, J.P. (2003). Logistics basics for purchasing and supply professionals. *Institute for Supply Management.* ISM's 88th Annual International Supply Management Conference - May 18-21, 2003

McKay, J. and Marshall, P. (2000). Quality and Rigour of Action Research in Information Systems. *Proceedings 8th European Conference on Information Systems*. Vienna, July 3-5th

McNiff, J. and Whitehead, J. (2000). Action research in organisations. ISBN: 1574443275. London - New York. *Routledge.*

Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zachaira, Z.G. (2001). Defining Supply Chain Management. *Journal of Business Logistics.* Vol. 22, No. 2, pp. 1-26.

Minahan, T. (2004). The E-procurement Benchmark Report: Less Hype, More Results. http://aberdeen.com/summary/report/benchmark/eProcurement122904b_TM.asp (accessed 03/2005).

Mintert, S. (2002). Big Business - Grundlage für globalen Handel (in German). *ix Special XML.* Vol. 1, pp. 110-115.

Mitchell, W.N. (1937). Purchasing. New York. *Ronald Press Co.*

Monczka, M. and Trent, R.J. (1995). Purchasing and Sourcing Strategy: Trends and Implications. ISBN: 0945968191. *Center for Advanced Purchasing Studies.*

Moonen, H.M. (2002). Collaboration in the Electronics Industry-Perspectives on business issues, processes and software. Master Thesis, Eindhoven: Eindhoven University of Technology.

Morgan, J.P. and Monczka, R.M. (2003). Why supply chains must be strategic. *Purchasing. ISSN: 1359-8546.*

Morgan, J.P., Monczka, R.M., (2003). Why supply chains must be strategic. *Purchasing.*

Morgan, M.S. and Morrison, M. (1999). Model as mediators. ISBN: 0521655714. Cambridge. *Cambridge University Press.*

Morrell, M. and Ezingeard, J.-N. (2002). Revisiting adoption factors of inter-organisational information systems in SMEs. *Logistics Information Management. ISSN 0957-6053.* Vol. 15, No. 1, pp. 46 - 57.

Morrissey, B. and Pittaway, L. (2004). A study of procurement behaviour in small firms. *Journal of Small Business and Enterprise Development. ISSN : 1462-6004.* Vol. 11, No. 2, pp. 254-262.

Mosey, S. (2005). Understanding new-to-market product development in SMEs. *International Journal of Operations & Production Management. ISSN 0144-3577.* Vol. 25, No. 2

Myers, M.D. (1997). Qualitative Research in Information Systems. *MIS Quarterly. ISSN: 0276-7783.* Vol. 21, No. 2, pp. 241-242.

Myers, M.D. (1997). Qualitative Research in Information Systems. *MIS Quarterly.* Vol. 21, No. 2, pp. 241-242.

National Statistics (2006). Information and Communication Technology (ICT) Activity of UK businesses 2004. http://www.statistics.gov.uk/downloads/theme_economy/ecommerce_report_2004.pdf

Needham, G. (2000). 'Research and Practice: making a difference' in R. Gomm and C. Davies, Using Evidence in Health and Social Care, ISBN: 0761964959. London. *Sage Publications.*

Neef, D. (2001). E-procurement: From strategy to implementation. Upper Saddle River, NJ. *Prentice-Hall.*

NePP (2004). National e-procurement project: Benefits Realisation Strand. www.idea.gov.uk/knowledge/eprocurement (Accessed 12/2005)

Nickols, F. (2003). Three forms of strategy. http://www.nickols.us.

NIGP (1996). Dictionary of Purchasing Terms. *National Institute of Governmental Purchasing.* http://www.nigp.org

Nilsson, A., Magnusson, J. and Enquist, H. (2003). SME network practice - a qualitative study of network management practice and design implications for ICT-support. *ECIS - European Conference on Information Systems.* Naples, Italy

Nokkentved, C. and Hedaa, L. (2001). Collaborative processes in esupply networks. *Journal of Retailing. ISSN: 0022-4359.* Vol. 76, No. 4, pp.

Nollet, J. and Beaulieu, M. (2005). Should an orgainsation join a purchasing group? *Supply Chain Management: An International Journal. ISSN 1359-8546.* Vol. 10, No. 1, pp. 11-17.

Nollet, J., Ponce, S. and Campbell, M. (2005). About "strategy" and "strategies" in supply management. *Journal of Purchasing and Supply Management. ISSN 1478-4092.* Vol. 11, No. 2/3, pp. 129-140.

Nyhuis, P. and Wiendahl, H.P. (2003). Logistische Kennlinien. ISBN: 3540437002 (in German). Berlin. *Springer.*

Oesterle, H., Fleisch, E. and Alt, R. (2000). Business networking - shaping enterprise relationships on the internet. ISBN: 3540666125. *Springer.*

Ogden, J.A., Petersen, K,J., Carter, J.R., Monczka, R.M., (2005). Supply management strategies for the future: A delphi study. *The Journal of Supply Chain Management.* Vol. August, pp. 29-48.

Olsen, K.A. and Saetre, P. (2007). ERP for SMEs - is proprietary software an alternative? *Business Process Management Journal. ISSN 1463-7154.* Vol. 13, No. 3, pp. 379-389.

Oxford (2000). Advanced Learner's Dictionary. *Oxford University Press.*

Parida, U. and Parida, V. (2003). Study of e-procurement strategies, risk and benefits: a case study. Luela University of Technology.

Parker, H. (2000). Interfirm collaboration and the new product development process. *Industrial Management and Data Systems.* Vol. 100, No. 6, pp. 255-260.

Parker, H. (2000). Interfirm collaboration and the new product development process. *Industrial Management & Data Systems. ISSN : 0263-5577.* Vol. 100, No. 6, pp. 255-260.

Pearcy, D.H., Giunipero, L.C. and Dandeo, L.M. (2004). An Analysis of e-Procurement Strategy: What Role Does Corporate Strategy Play? *Proceedings of the 13th International Purchasing and Supply Education and Research Association Conference.*

Peecher, M.E. and Solomon, I. (2001). Theory and Experimentation in Studies of Audit Judgments and Decisions: Avoiding Common Research Traps *International Journal of Auditing. ISSN 1090-6738.* Vol. 5, No. 3, pp. 193-203.

Perry, C. (1998). A structured approach to presenting theses. *Australasian Marketing Journal.* Vol. 6, No. 1, pp. 63-85.

Perry, C. and Zuber-Skerritt, O. (1992). Action Research in Graduate Management Research Programs. *Higher Education. ISSN 0018-1560.* Vol. 23, No. 2, pp. 195-208.

Perry, C., Zuber-Skerritt, O., (1994). Doctorates by Action Research for Senior Practising Managers *Management Learning.* Vol. 25, No. 2, pp. 341-364.

Pittiglio, Rabin, Todd and McGarth (1999). Managing your supply chain in the 21st century. www.prtm.com/brochures/supply_chain.pdf (Accessed 10/2003)

PLS RAMBOLL (2001). Collaborative SME-Commerce. http://www.pls-ramboll.com

PMG (2005). The Performance Measurement Group. http://www.pmgbenchmarking.com (Accessed 05/2005)

PMG (2005). The Performance Measurement Group (Accessed 2005). http://www.pmgbenchmarking.com

Podolny, J.M. and Page, K.L. (1998). Network forrms of organisation. *Annual Review of Sociology. ISSN: 0360-0572.* Vol. 24, pp. 57-76.

Poirier, C.C. (2003). The supply chain manager's problem-solver. Boca Raton, Florida. *St. Lucie Press.*

Poirier, C.C. (2003). The Supply Chain Manager's Problem-solver: Maximizing the Value of Collaboration and Technology. ISBN: 1574443356. Boca Raton, Florida. *St. Lucie Press.*

Poirier, C.C. and Bauer, M.J. (2000). E-supply chain: Using the Internet to revolutionize your business. ISBN: 1576751171. San Francisco, CA. *Berrett-Koehler Publishers.*

Popper, K.R. (1959). The logic of scientific discovery. ISBN: 0415278449. London. *Hutchison.*

Porter, A.M. (2000). The hunt for interoperability. *Purchasing, www.manufacturing.net/magazine/purchasing/.* Vol. June.

Porter, M.E. (1980). Competitive Strategy. New York. *Free Press.*

Porter, M.E. (1980). Competitive Strategy. ISBN: 0743260880. New York. *Free Press.*

Porter, M.E. (1985). Competitive Advantage. New York. *The Free Press.*

Porter, M.E. (1985). Competitive Advantage. ISBN: 0029250900. New York. *The Free Press.*

Porter, M.E. (1996). What is strategy? *Harvard Business Review.* Vol. Nov-Dec, pp. 61-78.

Porter, M.E. (2001). Strategy and the internet. *Harvard Business Review. ISSN: 0017-8012.* Vol. 79, No. 3, pp. 62-78.

Porter, W.M., McKibbin, L.E., (1988). Management Education and Development: Drift or Thrust into the 2lst Century? New York. *McGraw-Hill.*

PriceWaterhouseCoopers (2000). Trust - not built at e-speed. www.pwcglobal.com

Prud'homme, A.M., Zsidisin, G.A. and Boyer, K.K. (2007). Continuity planning for improved supply chain performance. 18th Annual North American Research/Teaching Symposium, Tempe, AZ.

PSL (2000). Vision 2010 - A report on the future of purchasing and supply. *Partnership Sourcing Ltd.* www.pslcbi.com

Puschmann, T. and Alt, R. (2005). Successful use of e-procurement in supply chains. *Supply Chain Management: An International Journal. ISSN 1359-8546.* Vol. 10, No. 2, pp. 122-133.

Quayle, M. (2002). Purchasing in small firms. *European Journal of Purchasing and Supply Management.* Vol. 8, No. 3, pp. 151-159.

Quayle, M. (2002). Purchasing in small firms. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 8, No. 3, pp. 151-159.

Quayle, M. (2003). E-business in a turbolent world: usage in European small and medium size enterprises. *International Journal of Electronic Business.* Vol. 1, No. 1, pp. 41-51.

Quinn, J.B. (1980). Strategies for change: Logical Incrementalism. Irwin Homewood IL.

Quinn, J.B. (1992). Intelligent Enterprise. ISBN: 0029256151. New York. *The Free Press.*

Ragin, C. (1987). The comparative Method, Moving Beyong Qualitative and Quantitative Method. ISBN: 0520066189. *University of California Press.*

Ramsay, J. (1996). The case against purchasing partnerships. *International Journal of Purchasing and Materials Management.* Vol. Fall, pp. 13-19.

Ramsey, J. (2001). Purchasing's strategic irrelevance. *European Journal of Purchasing and Supply Management.* Vol. 7, No. 4, pp. 257-263.

Ramsey, J. (2001). Purchasing's strategic irrelevance. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 7, No. 4, pp. 257-263.

Razi, M.A., Tarn, J.M. and Siddiqui, F.A. (2004). Exploring the failure and success of DotComs. *Information Management & Computer Security. ISSN: 0968-5227.* Vol. 12, No. 3, pp. 228-244.

Reason, P. (1994). Three approaches to participatory inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of Qualitative Research (pp. 324-339). Thousand Oaks, CA. *Sage.*

Reeds, J.D. (2000). Toward An Understanding of Supply Chain Management in:Don't Just Survive: Thrive!: The Contracting Professional as Business Manager. *National Contract Management Association (NCMA).* http://www.reedsresearch.com/Henley/papers/scmpap.html

Reichenbach, R. (1938). Experience and Prediction: An Analysis of the Foundations and the Structure of Knowledge. ISBN: 0268040559. *Phoenix Books, The University of Chicago Press.*

Remenyi, D., Williams, B., Money, A. and Swartz, E. (1998). Doing Research in Business and Management - An Introduction to Process and Method. ISBN: 0761959505. London. *Sage Publications.*

Reynolds, P.D. (1971). A primer on theory construction. New York. *Macmillan Publishing.*

Riemer, K., Gogolin, M. and Klein S. (2002). Introduction to Organizational Networks. *University of Muenster, Teaching Note.* www.wi.uni-muenster.de/wi/studieren/izi/ss05/IOS_networks_reader_SS05.pdf (Accessed 08/2002)

Roberts, M. and Wood, M. (2002). The strategic use of computerised information systems by a micro enterprise. *Logistics Information Management. ISSN 0957-6053.* Vol. 15, No. 2, pp. 115 - 125.

Robson, C. (2002). Real world research. London. *Blackwell, UK.*

RosettaNet (2004). RosettaNet Partner Interface Processes (PIPs). www.rosettanet.org (Accessed 06/2004)

Rozemeijer, F. (2000). Creating Corporate Advantage in Purchasing. Doctoral thesis, Eindhoven University of Technology.

Salo, R. and Lukka, A. (2004). Value added logistics in supply and demand chaines, Research Report 152, Department of Industrial Engineering and Management, Lappeenranta University of Technology. www2.lut.fi/tutkimus/valore/projects/laitosraportti_raija.pdf (Accessed 09/2005)

Sanders, N.R. (2005). IT alignment in supply chain relationschips: a study of supplier benefits. *Journal of Supply Chain Management.* Vol. 41, No. 2, pp. 4-12.

Savasaneril, S. (2004). Collaborative procurement and due date management in supply chains. *School of Industrial and Systems Engineering*. Georgia Institute of Technology.

Scandura, T.A. and Williams, E.A. (2000). Research Methodology in Management: Current Practices, Trends, and Implications for Future Research. *The Academy of Management Journal. ISSN: 0001-4273.* Vol. 43, No. 6, pp. 1248-1264.

SCC (2004). Supply Chain Operations Reference model. *Supply Chain Council.*

Schotanus, F. (2005). Cooperative Purchasing in the United Nations. *IPSERA*.

Schotanus, F. (2007). Horizontal Cooperative Purchasing. Doctoral thesis, University of Twente.

Schotanus, F., Telgan, J,. de Boer, L., (2004). Unfair Division of Gains under Equal Price in Cooperative Purchasing. Budapest

Schotanus, F., Telgen, J., (2005). Implications of a Classification of Forms of Cooperative Purchasing. IMP conference.

Schotanus, F., Telgen, T., (2007). Developing a typology of organisational forms of cooperative purchasing. *Journal of Purchasing and Supply Management. ISSN 1478-4092.* Vol. 13, No. 1, pp. 53-68.

Scott, T. (2002). Aligning your data collaction and ERP implementation decisions. *IT paper*. www.unova.com/whitepaper_align.asp

Sen, A. (1980). Description as choice. *Oxford Economic Papers.* Vol. 3, pp. 353-369.

Serve, M., Yen, D.C., Wang, J.-C. and Lin, B. (2002). B2B-enhanced supply chain process: toward building virtual enterprises. *Business Process Management Journal. ISSN 1463-7154.* Vol. 8, No. 3, pp. 245-253.

Sharif, A., Irani, Z. and Love, P. (2005). Integrating ERP using EAI: a model for post hoc evaluation *European Journal of Information Systems. ISSN: 0960-085X.* Vol. 14, No. 2, pp. 162-174.

Sharif, A., Irani, Z., Love, P., (2005). Integrating ERP using EAI: a model for post hoc evaluation *European Journal of Information Systems.* Vol. 14, No. 2, pp. 162-174.

Sherer, S.A. (2003). Critical success fatctors for manufacturing networks as perceived by network coordinators. *Journal of Small Business Management.* Vol. 41, No. 4, pp. 325-345.

Sherer, S.A. and Adams, A. (2001). Collaborative Commerce, The role of intermediaries in e-collaboration. *Journal of Electronic Commerce Research.* Vol. 2, No. 1, pp. 66-77.

Sherer, S.A., Adams, A., (2001). Collaborative Commerce, The role of intermediaries in e-collaboration. *Journal of Electronic Commerce Research.* Vol. 2, No. 1, pp. 66-77.

Sickinger, J.L. (1996). Coalition And Consortium Purchasing Power: It's Big, It's Here, And It's The Future Of Strategic Purchasing. *NAPM Annual International Conference*. Chicago, IL

Silverman, D. (2005). Doing Qualitative Research: A Practical Handbook. London.

Simatupang, T.M., Wright A.C and Sridharan, R. (2002). The knowledge of coordination for supply chain integration. *Business Process Management Journal. ISSN 1463-7154.* Vol. 8, No. 3, pp. 289 - 308.

Smeltzer, L.R. and Carter, J. (2001). How to built an e-procurement strategy. *Supply Chain Management Review. ISSN 1521-9747.* Vol. March/April, pp. 76-83.

Smith, M.E. and Buddress, L. (2005). Making purchasing work for smaller organisations. *Institute for Supply Management*. 90th Annual International Conference Proceedings - 2005 - San Antonio, TX

SOED (2002). New Shorter Oxford English Dictionary. *Oxford University Press.*

Software AG (2005). Definition Enterprise Ressource Planning (ERP), Accessed 2005. http://www.softwareag.com/xml/about/glossary.htm#E

Soh, C., Kien, S.S. and Tay-Yap, J. (2000). Enterprise resource planning: cultural fits and misfits: is ERP a universal solution? *Communications of the ACM. ISSN: 0001-0782.* Vol. 43, No. 4, pp. 47 - 51

Stannack, P. (2003). Strategy and strategic procurement. *The Chartered Institute of Purchasing and Supply.*

Starks, L. (2003). E-Procurement Success: It's About the Process, Not the Technology. *Institute for Supply Management*. 88th Annual International Conference Proceedings - 2003 - Nashville, TN

Stefansson, G. (2002). Business-to-business data sharing: A source for integration of supply chains. *International Journal of Production Economics. ISSN 0925-5273.* Vol. 75, No. 1-2, pp. 135-146.

Stefansson, G. (2002). Business-to-business data sharing: A source for integration of supply chains. *International Journal of Production Economics.* Vol. 75, No. 1-2, pp. 135-146.

Steger-Jensen, K. and Hvolby, H.-H. (2002). Review of B2B Integration. *Eighth International Conference on Advances in Production Management*

Systems "Collaborative Systems for Production Management". Eindhoven, The Netherlands

Stock, G.N., Greis N.P. and Kasarda, J.D. (1998). Logistics, strategy and structure: A conceptual framework. *International Journal of Operations & Production Management. ISSN 0144-3577.* Vol. 18, No. 1, pp. 37-52.

Stock, G.N., Greis N.P., Kasarda, J.D., (2000). Enterprise logistics and supply chain structure: the role of fit. *Journal of Operations Management. ISSN 0272-6963.* Vol. 18, No. 5, pp. 531-547.

Storey, J., Emberson, C. and Reade, D. (2005). The barriers to customer responsive supply chain management. *International Journal of Operations & Production Management. ISSN 0144-3577.* Vol. 25, No. 3, pp. 242-260.

Street, C.T., Cameron, A., (2007). External Relationships and the Small Business: A Review of Small Business Alliance and Network Research. *Journal of Small Business Management.* Vol. 45, No. 2, pp. 239–266.

Stringer, E.T. (1996). Action Research: A Handbook for Practitioners. Thousand Oaks, CA. *Sage Publications.*

Sturgeon, T.J. (2001). How do we define value chains and production networks? *IDS Bulletin. ISSN: 0265-5012.* Vol. 32, No. 3, pp. 9-18.

Svensson, C. and Barfod, A. (2002). Limits and opportunities in mass customization for "build to order" SMEs. *Computers in Industry. ISSN: 0166-3615.* Vol. 49, No. 1, pp. 77-89.

Tan, G.W. and Shaw, M.J. (1998). Applying component Technology to improve global supply chain network management. *19 International Conference on Information Systems.*

Tan, G.W., Shaw, M.J., (1998). Applying component Technology to improve global supply chain network management. *19 International Conference on Information Systems.*

Tan, K.C. (2001). A framework of supply chain management literature. *European Journal of Purchasing and Supply Management.* Vol. 7, No. 1, pp. 39-48.

Tang, N.K.H., Benton, H., Love, D., Albores, P., Ball, B., MacBryde, J., Boughton, N. and Drake, P. (2004). Develpping an enterprise simulator to support electronic supply-chain management for B2B electronic business. *Production Planning and Control. ISSN 0953-7287.* Vol. 15, 6, pp. 572-583.

Tarn, J.M., Yen, D.C. and Beaumont, M. (2002). Exploring the rationales for ERP and SCM integration. *Industrial Management & Data Systems. ISSN : 0263-5577.* Vol. 102, No. 1, pp. 26-34.

Taylor, M. and Murphy, A. (2004). SMEs and e-business. *Jounal of Small Business ans Enterprise Development.* Vol. 11, No. 3, pp. 280-289.

Telgen, J. (1988). Verzin een list! (in Dutch). *University of Twente, Enschede, Netherlans.*

Tella, E. and Virolainen, V.-M. (2005). Motives behind purchasing consortia. *International Journal of Production Economics. ISSN 0925-5273.* Vol. 93-94, No. 1, pp. 161-168.

Thorelli, H.B. (1986). Networks: Between Markets and Hierarchies. *Strategic Management Journal. ISSN: 0143-2095.* Vol. 7, No. 1, pp. 37-51.

Trent, R.J., Monczka R.M., (2003). Understanding integrated global sourcing. *International Journal of Physical Distribution and Logistics Management. ISSN: 0960-0035.* Vol. 33, No. 7, pp. 607 - 629.

van Everdingen, Y., van Hillegersberg, J. and Waarts, E. (2000). Enterprise resource planning: ERP adoption by European midsize companies *Communications of the ACM. ISSN: 0001-0782.* Vol. 43, No. 4 pp. 27 - 31.

van Stekelenborg, R. (1997). Information technology for purchasing. Doctoral thesis, Eindhoven University of Technology.

van Weele, A.J. (2005). Purchasing and Supply Chain Management. *Thomson Learning.*

van Wijk, R. (2003). Organizing Knowledge in Internal Networks; A Multilevel Study http://repub.eur.nl/publications/index/945616591/

Vanhaverbeke, W. (2001). Realizing new regional core competencies: establishing a customer-oriented SME network *Entrepreneurship & Regional Development. ISSN 0898-5626.* Vol. 13, No. 2, pp. 97 - 116.

Varamaki, E. (1996). The Development Process of Interfirm Cooperation of SMEs. *Frontiers of Entrepreneurship Research. ISBN: 091089714X.* Vol. 16, June, Babson Park, MA.

Varamaki, E. and Vesalainen, J. (2003). Modelling different types of multilateral co-operation between SMEs. *Entrepreneurship and Regional Development. ISSN: 0898-5626.* Vol. 15, No. 1, pp. 27-47.

VICS (2004). Collaborative Planning, Forecasting and Replenishment. *Voluntary Interindustry Commerce Standards Association.* www.cpfr.org

Vogt, O. and Maropoulos, P.G. (2002). Overcoming E-Procurement Failure of SMEs - the E-Translator. CIRP. *Digital Enterprise Technology (DET02).* Durham, UK

Vogt, O. and Maropoulos, P.G. (2004). Deployment of an IT solution for collaborative e-procurement of a group of SMEs. CIRP. *Seminar on Digital Enterprise Technology (DET04).* Seattle, USA

Wang, S. and Archer, N. (2004). Supporting collaboration in business-to-business electronic marketplaces. *Journal Information Systems and E-Business Management. ISSN: 1617-9846.* Vol. 2, No. 2-3, pp. 269-286.

Wang, Y. (2005). E-collaboration: a literature review. *Proceedings of the 2nd I*PROMS Virtual International Conference on Intelligent Production Machines and Systems, 3-14 July.*

Webber, S.S. (2002). Leadership and trust facilitating cross-functional team success. *Journal of Management Development. ISSN : 0262-1711.* Vol. 21, No. 3, pp. 201 - 214.

Westbrook, R. (1995). Action research: a new paradigm for research in production and operations management *International Journal of Operations & Production Management. ISSN 0144-3577.* Vol. 15, No. 12, pp. 6 - 20.

White, P. and Hanmer-Lloyd, S. (1999). Managing the input market: the strategic challenge. *European Journal of Purchasing and Supply Management. ISSN 0969-7012.* Vol. 5, No. 1, pp. 23-31.

Whitehead, J. (1994). How Do I Improve the Quality of My Management? A Participatory Action Research Approach *Management Learning. ISSN: 1350-5076.* Vol. 25, No. 1, pp. 137-153.

Wiendahl, H.P. and Lutz, S. (2002). Production in Networks. *Annals of the CIRP. ISSN: 0007-8506.* Vol. 51, No. 2, pp. 1-14.

Williams, S.J. (2006). Managing and developing suppliers: can SCM be adopted by SMEs? *International Journal of Production Research.* Vol. 44, No. 18-19, pp. 3831-3846.

Wokutch, R.E. (1979). Measuring corporate social performance: The problem of values. *Evaluation and Program Planning.* Vol. 2, No. 1, pp. 17-24.

Wolcott, H. (2001). Writing up qualitative research. CA. *SAGE Publications.*

Wooten, B. (2003). Cooperative purchasing in the 21st century. *Inside Supply Management. ISSN: 1538-733X.* Vol. 14, No. 2, pp. 4-7.

Wyld, D.C. (2004). The weather report for the supply chain: A longitudinal analysis of the ISM/Forrester Research in supply Management 2001-2003. *Management Research News.* Vol. 27, No. 1/2, pp. 1 - 26.

Yin, R.K. (1994). Case study research: Design and methods. Newbury Park, CA. *Sage.*

Yin, R.K. (1994). Case study research: Design and methods. ISBN: 0803956622. Newbury Park, CA. *Sage.*

Zeng, J., Harland, C., Johnsen, T. and Lamming, R. (1999). Methodological issues in interorganisational supply networks research. *In: Bartezzaghi, E. et. al (ed.) Managing Operations Networks, EUROMA, Venice, Italy*

Zheng, J., Caldwell, N., Harland, C., Powell, P., Woerndl, M. and Xu, S. (2004). Small firms and e-business: cautiousness, contingency and cost-benefit. *Journal of Purchasing and Supply Management. ISSN 1478-4092.* Vol. 10, No. pp. 27-39.

APPENDIXES

APPENDIX A: DEF ACTIVITIES AND MEMBER COMPANIES

DEF Member Companies

C A V Aerospace	www.cav-aerospace.net
DW Engineering	www.dweng.co.uk
Doby Verrolec	www.doby.co.uk
Donyal Engineering	www.donyal.co.uk
Dyer Engineering	www.dyer-engineering.ltd.uk
Electrak	www.electrak.co.uk
G T Project Engineering	www.gtgroup.co.uk
Hazardous Technical Services	www.hazardousts.com
Hiatco	www.hiatco.com
HyTech Fluid Solutions & Projects	www.hytechfsp.co.uk
International Cuisine	www.internationalcuisine.uk.com
Ionbond UK	www.ionbond.com
K C Engineering	www.kceng.com/uk

Lamplas	www.lamplas.co.uk
Maritime & Rail	www.maritimeandrail.com
Microbac	www.microbac.co.uk
M I S	www.mis-environmental.co.uk
Nicholsons Group	www.nicholsons.co.uk
Protocol Engineering	www.protocol-engineering.co.uk
Radford Shelving	www.radford.co.uk
Roberts Forge Lift	www.robertsforgelift.co.uk
Romag	www.romag.co.uk
R S Conveyors	www.rsconveyors.com
Schmitz Cargobull	www.cargobull.com
S K Plastics	www.skplastics.co.uk
Tanfield Engineering Systems	www.tanfieldengineeringsystems.com

Schools Road Show: Derwentside Engineering Forum has organised an annual "Engineering Roadshow" to raise the profile of engineering as a potential career for young people. This is a new initiative, targeting 1300 year 9 pupils prior to choosing their GCSE options. The importance of this initiative was highlighted by the attendance of local MPs at the Road Show. The Forum was supported by several local organisations including: Derwentside College, Durham University School of Engineering The Engineering Employers Federation, The Year in Industry Scheme, The R.E.M.E (Recruitment), The Royal Engineers (Recruitment), CITB (Construction Industry Training Board), Newcastle Aviation Academy, County Durham Business & Learning Partnership, Royal Academy of

Engineering's "BEST" Programme, Construction Industry Training Board, Skilltraining Ltd. and The Volunteer Bureau.

Schools Engineering Challenge: The Engineering Forum invests in an industry-education partnership by introducing an "engineering challenge" to the six secondary schools in the Derwentside area. Each school is allocated two Forum member companies to act as mentors to support the initiative. Designed to encourage young people to consider engineering as a career, the programme has been developed to complement the curriculum in schools and improve the breadth of delivery of science and technology subjects. One hundred students are invited annually to participate in the event.

In partnership with Derwentside College, DEF has already been successful in addressing skill shortages by securing improvements to the infrastructure for the enrolment of young people into engineering. The sustainability of this initiative ensures the quality and availability of skills match the needs of a growing engineering sector. The College now offers specialised courses in computer-aided design/manufacture and high tech engineering, as well as traditional courses in engineering. This unique blend of public and private sector partnership is contributing to the social and economic regeneration of Derwentside by creating conditions that will allow the engineering and manufacturing sectors to develop.

Neighbourhood Engineers: In addition to the Road Show and the Challenge, Derwentside Engineering Forum also visits primary schools to increase the awareness of the important role engineering plays in the community and to attract young people to consider a career in engineering. The Neighbourhood Engineers Program plays an important role in enhancing young people's knowledge and understanding of the importance of engineering in our society. The program involves "ambassadors" with an engineering background who volunteer as Neighbourhood Engineers to visit local primary schools and provide practical support to assist the school curriculum and enhance the learning of young people. Such was the success of the initiative in Primary Schools in previous years in Derwentside that a programme of about 20 annual events had been agreed.

Apprentice of the year: Derwentside Engineering Forum "Apprentice of the Year Award" is awarded annually to apprentices at the Derwentside College for showing extraordinary skills and achievements in engineering, for example two apprentices from Hiatco Ltd. where reaching the national final of "Skillweld 2004", a welding competition by The Welding Institute (TWI).

New Product Development: Derwentside Engineering Forum offers assistance with new product and process development to support growth and competitiveness within existing businesses. The initiative also seeks to encourage and identify potential business start-up opportunities too. The main objective is to provide an integrated package of support, advice and consultancy on new product development for companies within the area. To create an increasingly self-reliant and robust economy requires new approaches to business, training and education development. Supporting new product development has been designed to increase the number of business start-ups in Derwentside and to support the growth, restructuring and sustainability of existing businesses.

Health, safety and environment: Derwentside Engineering Forum has formed a Health, Safety and Environment Working Group to enable companies to cooperate and to set up a dialogue for beneficial collaboration. The purpose is to look at the advantages of member companies collaborating on all Health, Safety and Environmental issues and to plan future strategy that will be beneficial to all. Responding to initial requirements the Forum has purchased a noise level meter, a label printer to supply members with health and safety signs on request, organised manual handling & risk assessment courses and facilitated environmental & health surveillance presentations.

Consultancy: The knowledge and experience of Derwentside Engineering Forum staff is used to support member companies in all aspects of business. Monthly Forum meetings are held and free cross table discussion often resolves problems as companies face similar situations. Often members share the same problem and advice is available together with associated financial savings. However, when a requirement is highlighted which cannot be resolved within the membership, the Forum will contact local Universities, Business Link, Centres of Excellence or other consultancy sources to investigate the matter further.

Training: Derwentside Engineering Forum provides training facilities and conducts training provider selection, customisation of content and dissemination to arrange the most appropriate package for the requirements of its members. Members identified a growing need for management and supervisor training for nominated personnel within their companies. As one example, a customised training programme for shop floor supervisors was developed in association with West End Training.

Management Support Helpline: Derwentside Engineering Forum members have access to a Management Support Helpline. Provided by Croner Consulting, the helpline offers expert advice in the following areas: employment and personnel, health and safety at work, debts and debt recovery, business legal issues, company law, licensing, payroll, tax and VAT.

British Standards Online: Derwentside Engineering Forum provides members with access to the British Standards Online web site. Each member has a unique account to download available standards. New standards can be added by DEF staff and are made available to members via the internet within minutes of being requested. Updated daily, the site includes over 38,500 current, draft and historic British Standards, more than 16,000 of which are BSI adopted European and International standards.

Quality Register: Derwentside Engineering Forum is a customer of the Quality Register, which is a database of quality-assessed companies (www.quality-register.co.uk). It lists quality awards made by certification bodies that have in turn been accredited by UKAS (the United Kingdom Accreditation Service). There are currently over 100 UKAS accredited bodies. The Register currently includes over 90,000 entries of companies with UKAS accredited certifications covering the UK and throughout the world.

Web Site and Newsletters: Derwentside Engineering Forum hosts its own web site www.def.org.uk that is controlled by the Forum and is used as a collaborative communication tool for members. Each member has a unique user name and password giving access to news and activities. All members are represented on the site and have links to their web sites and brochure details. The Forum publicises a quarterly newsletter to inform the community of its activities and latest developments.

Integrated Engineering Services: Derwentside Engineering Forum acts as a facilitator to offer "Integrated Engineering Services" to deliver turnkey solutions. The Forum members offer a unique blend of skills, resources and technologies. Currently hosting a membership of 30 organisations the Forum offers a diverse range of engineering services and products (Figure 70).

General engineering ▪ sheet metal and press work ▪ laser and water jet cutting ▪ precision engineering ▪ engineering in aluminium ▪ specialist metals and plastics ▪ sealing technologies ▪ white metal bearings ▪ shelving solutions ▪ thin film surface engineering▪ low power distribution and lighting control systems ▪ refrigeration and curtain sided semi-trailers ▪ ductwork components ▪ roll formed metal sections ▪ industrial plastic components ▪ biomass engineering and waste water treatment ▪ composite glass fibre and thermoformed mouldings ▪ steel fabrications ▪ profiling ▪ welding specialists ▪

profiling • welding specialists • aerospace solutions • paint finishing • hydraulic solutions • automatic vision checking systems • lifting specialists • stair and bath lifts • touring caravans and motor homes • roller shutter door profiles • civil and structural consultant engineers • one-off conveyors and complete systems

Figure 70: DEF member's products and services

The concept of "Integrated Engineering Services" was presented recently to prospective buyers at the SubCon, RailTec, Irish, Northern, Midlands and Southern Manufacturing Exhibitions and attracted a high level of interest from both the public and private sector. Derwentside Engineering Forum's role as facilitator ensures quality delivery, competitiveness and "Quality products delivered on time at the right price". Integrated Engineering Services is unique and benefits include:

- Competitors working together to deliver cost effective turnkey solutions;
- Unique blend of skills and expertise within a 10 mile radius of the facilitation hub;
- Best practise and knowledge transfer between companies;
- Facilitation and project management;
- Internal competitive tendering between companies;
- Derwentside Engineering Forums support service.

Marketing: Derwentside Engineering Forum supports its collective membership by actively searching for tender opportunities and identifying trading and inter-trading opportunities. The Forum assists with the development of marketing strategies and facilitation of collective marketing and sales. The Forum produces a brochure for each individual member and as well as being available for members to use for their own promotional needs, they are collated into a folder to market the overall theme of

"Integrated Engineering Services for Turnkey Solutions". Company sales personnel attend exhibitions on a rota basis, which has proved to be cost effective and useful networking tool, have staffed the stands. The Forum has already received enquiries and orders for collaborative work because of the exhibitions and through existing company customers.

Business Continuation Management: Derwentside Engineering Forum is developing a proactive response system to protect companies against the crisis forces that may impede the continuance of their business. Working in partnership with Derwentside District Council (DDC) a combined Crisis Management facility for existing businesses and Hot Desk facility for new start-up companies has been developed. Member companies collaborate and operate a pooled resource principal to assist companies in crisis. Initially the facility will provide a first level recovery facility (Crisis Centre) and will be made available to companies in the event of a major crisis. The initiative will be further developed to provide training and generic Crisis Management Planning and IT backup facilities. On the other hand, DDC operates a Hot Desk for young companies that cannot afford their own office from the beginning. The integration of the two initiatives has proved to be cost effective by catering for the everyday need of the hot desk initiative and offering support and accommodation to companies in crisis.

Work and wages survey: Derwentside Engineering Forum carries out an annual wages and salary survey throughout the membership. All individual company data is collated and average wages for trades and professions is documented and issued as a confidential document to members.

Credit rating check: Derwentside Engineering Forum subscribed to a service providing information about accounts and credit rating of UK companies to minimise supply chain risks of member companies when trading with new partners.

Collaborative purchasing and e-commerce: Derwentside Engineering Forum encourages all members to operate on-line and to take advantage the e-commerce facilities available. The Forum has witnessed considerable savings through collaborative purchasing initiatives and the utilisation of leverage generated by the group's numbers. An electronic reverse auction facility offers utility suppliers the opportunity to bid for electricity and gas contracts. Savings in excess of £175k have been generated through tariff analysis and negotiation of existing utility contracts; this equates to more than £1m sales. Considerable savings have also been achieved through the purchase of other goods such as stationery and work wear. Most information given in this research relates to this initiative.

Appendix B: Fax-back forms for collaborative electricity purchasing

The following fax-back forms were used during a collaborative purchasing exercise. In particular interesting is the look after return, e.g. grease stains.

13/12/2000 17:15 +44-1207-599810 GRORUD ENG PAGE 01
01207 582812
12/12 '00 TUE 13:33 FAX 01207 582812 AS&T 001

DAVID JOHNSTON.
GRORUD ENGINEERING.

engineering enterprise
Derwentside

COMPANY NAME: GRORUD ENG. (DAVID JOHNSTON) DATE: DEC 2000
FAX: 01207 509146

PURCHASING
-
ELECTRICITY SURVEY

QUESTIONS	ANSWERS	COMMENTS
CURRENT ELECTRICITY SUPPLIER	EASTERN ELECTRICITY	
PRICE OF ELECTRICY IN PENCE PER kiloWatt hour (kWh)		
IF APPROPRIATE SPECIFY OTHER RATES IN PENCE PER kWh: DAY / NIGHT / WEEKEND	Fac 1 4.110 / 2.169 / n/a Fac 2 7.573 1.993 n/a	Unit charges
SUPPLIER MONTHLY CHARGE WHERE APPLICABLE (£)	Fac 1 71.43 Fac 2 15.74	MAXIMUM CHARGE STANDING CHARGE
TOTAL ELECTRICY kWh USAGE IN SEPTEMBER	Fac 1 181,000 units Fac 2 87,500 units	Units consumed
TOTAL ELECTRICY kWh USAGE IN OCTOBER	—	Not yet invoiced
TOTAL ELECTRICY kWh USAGE IN NOVEMBER	—	— " —
CURRENT ELECTRICITY SUPPLIER CONTRACT TERMINATION DATE (month / year)	Sep 2001	
DOES YOUR ELECTRICY SUPPLIER ALSO PROVIDE GAS?	No	Powergen
PRICE OF GAS IN PENCE PER MJ/m^3	40.400 MJ/m^3	
TOTAL ANNUAL USAGE (THERMS)	283,000	

N.B. PLEASE COMPLETE AND FAX RETURN TO JOHN HODGSON BY MONDAY 18 DECEMBER 2000 @ fax no 07092 100191

JOHN LYLE.

COPY. 12/11/2000 1-35pm.

engineering enterprise Derwentside

COMPANY NAME: AS&T

FAX: 01207 582812

DATE: DEC 2000

PURCHASING
-
ELECTRICITY SURVEY

QUESTIONS	ANSWERS	COMMENTS
CURRENT ELECTRICITY SUPPLIER	NORTHERN ELECTRIC	NORTHERN ELECTRIC
PRICE OF ELECTRICY IN PENCE PER kiloWatt hour (kWh)	2000 KVA SUPPLY	500KVA SUPPLY
IF APPROPRIATE SPECIFY OTHER RATES IN PENCE PER kWh: DAY / NIGHT / WEEKEND	4.77p 2.34p .... DAY / NIGHT	4.18/2.39/7.64p Std / Night / Winter Day
SUPPLIER MONTHLY CHARGE WHERE APPLICABLE (£)	£1960	£460
TOTAL ELECTRICY kWh USAGE IN SEPTEMBER	DAY 232995 / NIGHT 91048	
TOTAL ELECTRICY kWh USAGE IN OCTOBER	213491 / 81174	
TOTAL ELECTRICY kWh USAGE IN NOVEMBER		56060/50711/80420 STD / NIGHT / WINTER
CURRENT ELECTRICITY SUPPLIER CONTRACT TERMINATION DATE (month / year)	DEC 2000	DEC 2000
DOES YOUR ELECTRICY SUPPLIER ALSO PROVIDE GAS?	No	No
PRICE OF GAS IN PENCE PER MJ/m³	0.77p / Kwh	
TOTAL ANNUAL USAGE (THERMS)	23752 KWh	

N.B. PLEASE COMPLETE AND FAX RETURN TO JOHN HODGSON BY MONDAY 18 DECEMBER 2000 @ fax no 07092 100191

15/12 '00 10:17 FAX 01207 591600 ROBERTS FORGE 001

DAVE ROBERTS.

engineering enterprise
Derwentside

COMPANY NAME: ROBERTS FORGE – LIFT. DATE: DEC 2000
FAX: 01207 591600

PURCHASING
-
ELECTRICITY SURVEY

QUESTIONS	ANSWERS	COMMENTS
CURRENT ELECTRICITY SUPPLIER PRICE OF ELECTRICY IN PENCE PER kiloWatt hour (kWh)	NORTHERN ELECTRIC	DON'T KNOW
IF APPROPRIATE SPECIFY OTHER RATES IN PENCE PER kWh: DAY / NIGHT / WEEKEND	......./......./.......	
SUPPLIER MONTHLY CHARGE WHERE APPLICABLE (£)	£40	
TOTAL ELECTRICY kWh USAGE IN SEPTEMBER	DON'T KNOW	
TOTAL ELECTRICY kWh USAGE IN OCTOBER	— " —	
TOTAL ELECTRICY kWh USAGE IN NOVEMBER	— " —	
CURRENT ELECTRICITY SUPPLIER CONTRACT TERMINATION DATE (month / year)	ONGOING	
DOES YOUR ELECTRICY SUPPLIER ALSO PROVIDE GAS?		NO
PRICE OF GAS IN PENCE PER MJ/m³ TOTAL ANNUAL USAGE (THERMS)	O	O

N.B. PLEASE COMPLETE AND FAX RETURN TO JOHN HODGSON BY MONDAY 18 DECEMBER 2000 @ fax no 07092 100191

15/12/2000 10:29 01702502434 DERWENTSIDE COLLEGE PAGE 02

FOR THE ATTENTION OF
MR ALBERT CRONEY.

engineering enterprise
Derwentside

COMPANY NAME: DERWENTSIDE COLLEGE. DATE: DEC 2000
FAX: 01207 502484

PURCHASING
-
ELECTRICITY SURVEY

QUESTIONS	ANSWERS	COMMENTS
CURRENT ELECTRICITY SUPPLIER	NORTERN ELECTRIC	
PRICE OF ELECTRICY IN PENCE PER kiloWatt hour (kWh)	DAY - 4.09p NIGHT - 2.11p	
IF APPROPRIATE SPECIFY OTHER RATES IN PENCE PER kWh: DAY / NIGHT / WEEKEND		
SUPPLIER MONTHLY CHARGE WHERE APPLICABLE (£)	→ £136-42 NGC SETTLEMENT CHARGE £30-83	CAPACITY CHARGE £270-00
TOTAL ELECTRICY kWh USAGE IN SEPTEMBER	41427	
TOTAL ELECTRICY kWh USAGE IN OCTOBER	47737	
TOTAL ELECTRICY kWh USAGE IN NOVEMBER	55711	
CURRENT ELECTRICITY SUPPLIER CONTRACT TERMINATION DATE (month / year)	MAY 2001	
DOES YOUR ELECTRICY SUPPLIER ALSO PROVIDE GAS?	NO	POWERGEN
PRICE OF GAS IN PENCE PER MJ/m³	1.220 p/kWh	
TOTAL ANNUAL USAGE (THERMS)	2,944,920 kWh	

N.B. PLEASE COMPLETE AND FAX RETURN TO JOHN HODGSON BY MONDAY 18 DECEMBER 2000 @ fax no 07092 100191

04/01 '01 THU 12:51 FAX

FOR THE ATTENTION OF DR. KEITH CHESTER

engineering enterprise Derwentside

COMPANY NAME: K.C. ENGINEERING.
FAX: 01207 581900

DATE: DEC 2000

PURCHASING

-

ELECTRICITY SURVEY

QUESTIONS	ANSWERS	COMMENTS
CURRENT ELECTRICITY SUPPLIER	NORTHERN EL & GAS	No Recent Bill
PRICE OF ELECTRICY IN PENCE PER kiloWatt hour (kWh)	1500 @ 8.37 Balance	7.40 [illegible]
IF APPROPRIATE SPECIFY OTHER RATES IN PENCE PER kWh: DAY / NIGHT / WEEKEND	7.9 / 2.45 /	Jan 2000 Prices
SUPPLIER MONTHLY CHARGE WHERE APPLICABLE (£)	£14.38 per QRT	
TOTAL ELECTRICY kWh USAGE IN SEPTEMBER	9640	
TOTAL ELECTRICY kWh USAGE IN OCTOBER	9915	
TOTAL ELECTRICY kWh USAGE IN NOVEMBER	9720	
CURRENT ELECTRICITY SUPPLIER CONTRACT TERMINATION DATE (month / year)	No Contract !!	
DOES YOUR ELECTRICY SUPPLIER ALSO PROVIDE GAS?	N/A !!	
PRICE OF GAS IN PENCE PER MJ/m^3	0.97 p. p KWH.	
TOTAL ANNUAL USAGE (THERMS)	APPROX 15200	EXPECT SIGNIFICANT INCREASE

N.B. PLEASE COMPLETE AND FAX RETURN TO JOHN HODGSON BY MONDAY 18 DECEMBER 2000 @ fax no 07092 100191

Fax : 15 Dec '00 10:09 P.01

LYNNE ~~HUDSPATCH~~ ERRINGTON.

engineering enterprise
Derwentside

COMPANY NAME: HIATCo LTD.
FAX: 01207 283599

DATE: DEC 2000

PURCHASING
-
ELECTRICITY SURVEY

QUESTIONS	ANSWERS	COMMENTS
CURRENT ELECTRICITY SUPPLIER	NORTHERN ELECT	
PRICE OF ELECTRICY IN PENCE PER kiloWatt hour (kWh)	£7.23p	
IF APPROPRIATE SPECIFY OTHER RATES IN PENCE PER kWh: DAY / NIGHT / WEEKEND	......./ ..../	
SUPPLIER MONTHLY CHARGE WHERE APPLICABLE (£) QTRLY	£22.20	
TOTAL ELECTRICY kWh USAGE IN SEPTEMBER		
TOTAL ELECTRICY kWh USAGE IN OCTOBER		15408
TOTAL ELECTRICY kWh USAGE IN NOVEMBER		
CURRENT ELECTRICITY SUPPLIER CONTRACT TERMINATION DATE (month / year)	30 DAYS	
DOES YOUR ELECTRICY SUPPLIER ALSO PROVIDE GAS?	NO	
PRICE OF GAS IN PENCE PER MJ/m³	£1.08p	
TOTAL ANNUAL USAGE (THERMS)		?

N.B. PLEASE COMPLETE AND FAX RETURN TO JOHN HODGSON BY MONDAY 18 DECEMBER 2000 @ fax no 07092 100191

20-DEC-2000 10:17 FROM IONBOND LIMITED TO 07092100191 P.01/01

For the attention of
ANDREW FROST.

To John Hodgson

engineering enterprise
Derwentside

COMPANY NAME: IONBOND. DATE: DEC 2000
FAX: 01207 590254

PURCHASING
-
ELECTRICITY SURVEY

QUESTIONS	ANSWERS	COMMENTS
CURRENT ELECTRICITY SUPPLIER	NORTHERN ELECTRIC	(CONSETT & MANSFIELD)
PRICE OF ELECTRICY IN PENCE PER kiloWatt hour (kWh)	DAY NIGHT	
IF APPROPRIATE SPECIFY OTHER RATES IN PENCE PER kWh: DAY / NIGHT / WEEKEND	3.93 / 2.15 /	
SUPPLIER MONTHLY CHARGE WHERE APPLICABLE (£)	£517	
TOTAL ELECTRICY kWh USAGE IN SEPTEMBER	76616 27335	DAY NIGHT
TOTAL ELECTRICY kWh USAGE IN OCTOBER	76400 27320	DAY NIGHT
TOTAL ELECTRICY kWh USAGE IN NOVEMBER	75930 27312	DAY NIGHT
CURRENT ELECTRICITY SUPPLIER CONTRACT TERMINATION DATE (month / year)	12/2000 ?	May have an extension
DOES YOUR ELECTRICY SUPPLIER ALSO PROVIDE GAS?	No	BRITISH GAS
PRICE OF GAS IN PENCE PER ~~M/HR~~	1.036 p/KWh	Sorry their units
TOTAL ANNUAL USAGE (~~THERMS~~)	250000 KWh	" "

N.B. PLEASE COMPLETE AND FAX RETURN TO JOHN HODGSON BY MONDAY 18 DECEMBER 2000 @ fax no 07092 100191

TOTAL P. 01

APPENDIX C: ICT SURVEY DATA

Company Information

id
login
pass
salt
numberofpcs
pcsnetworked
itstaff
telephones
internetconnection
lanconnection
emailprovider
ename
eemail
ephone
internetprovider
iname
iemail
iphone
telephoneprovider
tname
temail
tphone
hardwareprovider
hname
hemail
hphone
erpconsultant
cname
cemail
cphone

Server Information

id
company_id
name
server_os_id
comment
processor
ram
diskspace
backup_media_id
other

Printer Information

id
company_id
brandt
model
printer_type_id
printer_format_id
printsperweek
comment

Printer Format

Other
A0
A1
A2
A3
A4
Endless Paper

Printer Type

Other
Ink Black & White
Ink Colour
Laser Black & White
Laser Colour
Multifunction
Plotter

Server OS

Other
Windows NT
Windows 2000
Windows 2003
Windows 95
Windows 98
Windows XP
Linux
AIX
SCO
APPLE OS
DOS
NETWARE

Software Type

Other
ERP
MS Word
MS Excel
MS Powerpoint
MS Outlook
MS Outlook Express
Antivirus Software
Backup Software
CAD Software
Email Server
Firewall Software
Web Server
Database Server
FAX Server
Grafic Suite
Development
Web Design
MS Office

Software Information

id
company_id
software_type_id
name
comment
server_os_id
numberofusers

Backup Information

id
company_id
server_id
software_id
backup_media_id
Intervall
Comment

Backup Media

Other
Hard disk
Floppy disk
CD RW
DAT Tape
DLT Tape
None

Table 14: ICT Survey: Database Table Columns

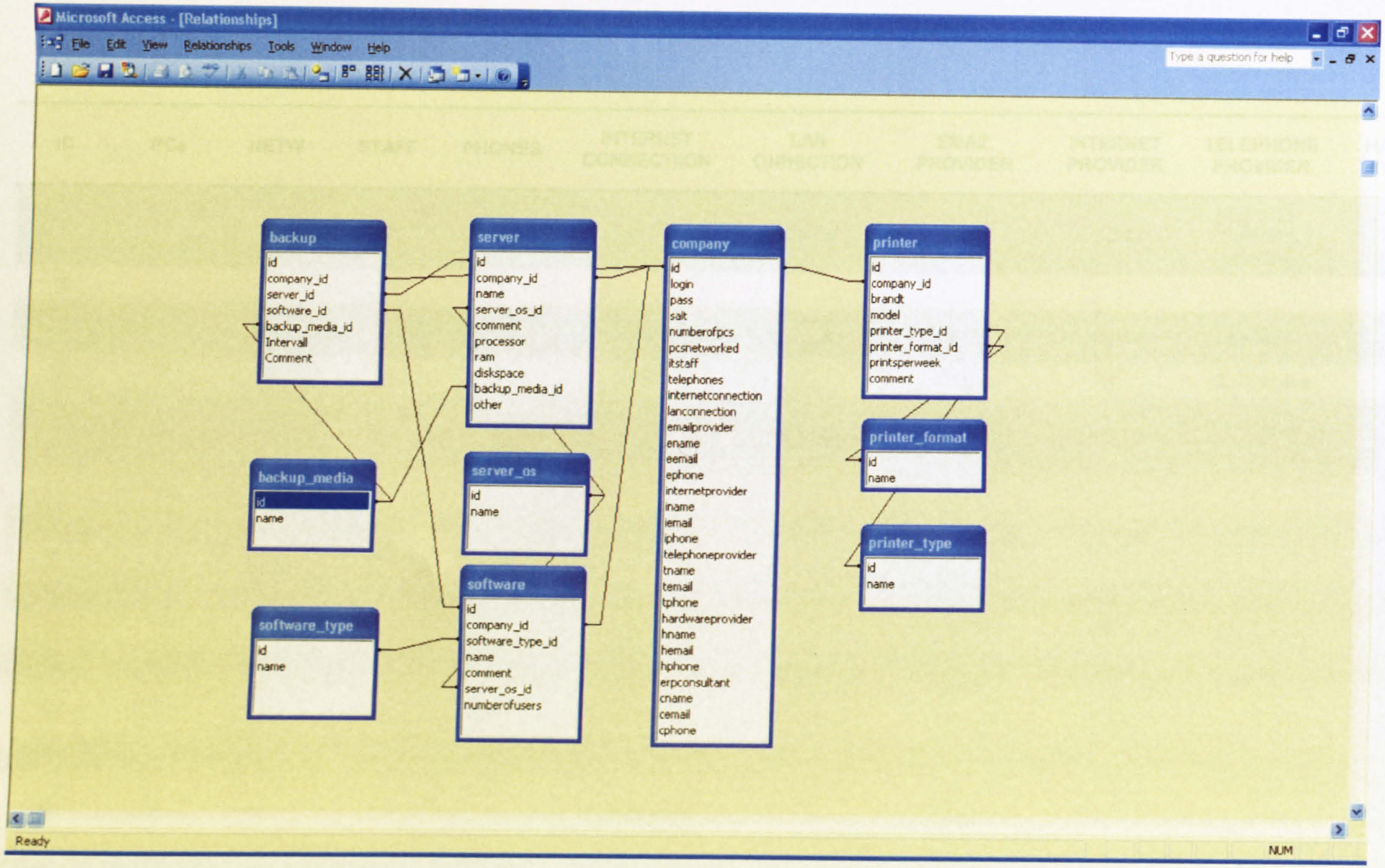


Figure 71: ICT Survey: Database Table Relations

ID	PCs	NETW	STAFF	PHONES	INTERNET CONNECTIION	LAN ONNECTION	EMAIL PROVIDER	INTERNET PROVIDER	TELEPHONE PROVIDER	HARDWARE PROVIDER	ERP CONSULTANT
1	8	8	8	3	LAN	Ethernet	DDC	DDC	Consett Business Centre	Dell	Sage
2											
3	95	95	3	100 (10lines)	ASDL	Ethernet, wireless	Demon	Demon	Excutel	Dell (and other)	Mapics
5	2	0	0	2	dial in	no	Yahoo	BT	XL Telecom	no	Sage direct
6	35	34	1	4	isdn	Ethernet	Durham Consultancies	Wanadoo	NE Chamber of Commerce	no	Increase Computers
7	100										
8	114	112	3	122	2MB	1000/100	Bronco	Telewest	BT	Contrac	Epicor
9											
10	2	0	0	4	dial-in	0	Freeserve	Freeserve	Bt	0	Sage
11	1	1	0	2	dial in	no	BT	BT	EurExcel	no	no
12	25	25	0	10	ASDL	Ethernet	Griffin	Pipex	BT	Dell	EXEL
13	25+	25+	1	30+	Leased Line	Ethernet	Star	Star	BT	Dell	
14											
15	4	4	1	1	Broadband		DDC			Matrox, IBus,PCworld, Dell	
16	3	3	0	3	ASDL	Ethernet	BT	BT	BT	PC World	Sage
17	120	120	3	30	ADSL 2Mbit	Ethernet	ClaraNet (via MessageLabs)	ClaraNet	ComTec	IBM	Geac - System 21
18											
19	25	25	1	6 lines / ISDN II	ADSL	Ethernet 10/100	Demaon Internet /	Demon	Process of Change	Dell	TSG Team Valley

ID	PCs	NETW	STAFF	PHONES	INTERNET CONNECTIION	LAN ONNECTION	EMAIL PROVIDER	INTERNET PROVIDER	TELEPHONE PROVIDER	HARDWARE PROVIDER	ERP CONSULTANT
20	13	13	0	4	adsl	ethernet	b-one	g-connect	Executel	Dell	Bowe Digital Access
21	3	2	0	3	Broadband	ethernet	register.com	DDC	DDC	none	none
22	85	75	5	3	ADSL	Ethernet	Demon	Demon	BT		in-house
23	120	120	3	10	ADLS	Ethernet, wireless	Easynet Plc.	Demon	IP integration	IBM	Minerva Plc.
24	2	no	0	3	ADSL	no	BT openworld	BT	BT	no	Charlton Williamson Partnership
25	14	13	0	6	ISDN	Ethernet					
26	1	1		2			Plusnet	Plusnet	BT		Sage Instant Accounts & Sage Payroll
27											
28											
29	16	16	0	5	ADSL	Ethernet	Plusnet	BT	BT	Nectar	Answers for Accounts (Newcastle)
30	6	4	0	7	ASDL	Wireless	BT	BT	BT	DELL	Sage Direct
31	100	100	1	30 (10core)	100Mbit to DDC	Ethernet	DDC	DDC	Telewest	Dell	Bowe Digital

Table 15: ICT Survey: Company Information

ID	Backup Media	Server	Software	Intervall	Comment
11	Other	Desktop PC	Sage	NO	Dont use the package
5	Floppy disk	Ann's PC	Sage	weekly	Two floppies D ROM planned
5	Floppy disk	John's PC	BobCad17	randomly	
5	Floppy disk	Ann's PC	Word	randomly	Drawings and process sheets (work plan)
15	CD RW	Desk PC	Visual C/C++	project related	20x master cd, 2x Backup local, 2x Home, 1x on customer site
15	CD RW	Desk PC	Turbo Cad	project related	
26	Floppy disk	Desktop PC	Sage Account & Payroll	Weekly	
26	CD RW	Desktop PC	AutoSketch	Not regular	MS Office files
21	Other	Office 1	Autocad 2000i LT	By Project	External Hard Disk
6	DLT Tape	SRV2	Ms Office	daily 40Gb	12 month , 4 weeks, 5 days
6	DLT Tape	SRV1	Ms Office	daily 10Gb	5 tapes (1 week)
25	DAT Tape	Newcastle	BPCS	daily	and to Headquarter
25	DAT Tape	Newcastle	MSS	daily	and to Headquarter
25	DAT Tape	Newcastle	OPERA	daily	and to Headquarter
10	Other	Secretary PC	MS Office	No backup	Wireless Lan recommended
10	Floppy disk	Secretary PC	Sage Payroll	Weekly	
17	Other	AS400	Geac System 21	daily 25GB	IBM special
20	DAT Tape	Engima	Sage Manufacturing and Fiancial Controller V10	Daily	20 GB
22	Hard disk	Retrospect	Retrospect	Daily	Clients and servers
19	DAT Tape	MAUKNT1	MS Office	daily	5 tapes for each
19	DAT Tape	MAUKNT2	Pegasus Opera	daily	Backup drive in MAUKNT3
19	DAT Tape	MAUKNT3	MS Exchange 2003 Standard	daily	dat 72 (incl MAUKNT2)
22	DAT Tape	NAS	Arcserve	Daily	Servers
22	DAT Tape	Verity	Backup Exec	Daily	Servers
30	CD RW	Kay's PC	Sage Sovereign	daily	

ID	Backup Media	Server	Software	Intervall	Comment
30	CD RW	Kay's PC	MS Office	on demand	
30	CD RW	Glen	MS Office	on demand	
30	CD RW	Graeme	MS Office	on demand	
30	Hard disk	Glen Dell	MS Office	on demand	Kay's PC
24	CD RW	Dave	MS Office	weekly	
24	Floppy disk	Lynne	Sage Line 50	daily	
29	DAT Tape	Sage Server	MS Office	daily	
29	DAT Tape	Sage Server	Sage Accounts	dailiy	
29	Other	Payroll	Sage Payroll	weekly	Zip drive, plus dial-in to Castleside factory's clock (work time)
16	CD RW	Jackies PC	MS Office	weekly	
16	CD RW	Jackies PC	Sage Payroll	weekly	
16	CD RW	Jackies PC	Sage Accounts	daily	
13	Other	Citrix1	MS Word	daily	Windows 2000 Backup via Network File transfer
13	Other	Navaho E-mail	MS Word	Daily	Navaho own backup software via file transfer
13	Other	Citrix2	MS Word	Daily	Zip file update copy to two separate computers
13	DAT Tape	Citrix2	MS Word	Daily	Tape Back Up using W2K Backup
23	DLT Tape	Newcastle5	MS Exchange 2003	mon to fri	40/80GB
23	DLT Tape	Newcastle1	Payroll Kempay	daily	
23	DLT Tape	Newcastle1	Time & Attendence Smart Systems	daily	
23	DLT Tape	Newcastle2	SQL Server 7	daily	
23	DLT Tape	Newcastle3	Workflow eWork	daily	Super DLT
23	DLT Tape	Newcastle4	MS Office	daily	NAS attached to Super DLT
23	DLT Tape	Newcastle6	Autodesk Inventor	daily	
23	DAT Tape	Radford1	MFG Pro	daily	
12	DAT Tape	NT_fs02	MS Office	daily	All data: ERP/office/Crystal/Jet Cam

ID	Backup Media	Server	Software	Intervall	Comment
1	DLT Tape	EMERGEDC	User Files	daily	Backup filesrv1, landc, appsrv/intepub and appsrv/vpop3
8	DLT Tape	Server 8	Retrospect	1 day	
8	Hard disk	Server 8	Retrospect	1 day	
31	Hard disk	Dell 6400	MS Exchange	3x per week	50GB
31	Hard disk	Dell 2400 File	User Files	3x per week	200GB
31	DAT Tape	Dell 2400 DC	Sage Line 100	3x week	20GB
31	DAT Tape	Dell 6400	Sage Payroll	3x per week	-
3	DLT Tape	PRO01	Syteline	daily	117GB
3	DLT Tape	SQL01	Office Talk	daily	

Table 16: ICT Survey: Backup Information

ID	Name	Backup Media	Server OS	Processor	RAM (MB)	Disk- space (GB)	Other
1	EMERGEDC	DAT Tape	Windows 2003	Pentium PIII 800	1024	34	-
1	LANDC	None	Windows 2003	Pentium III 1.26	768	12	
1	FILESRV1	None	Windows 2003	Celeron 2.4	512	700	
1	APPSRV1	DLT Tape	Windows 2003	2x Xenon 2.40	512	10	Tape Device: PV-110T LTO
1	DMZDC	None	Windows 2003	Celeron 2.4	512	10	
3	SRV01	None	Windows 2000				
3	PRO01	DLT Tape	Windows 2000				
3	APS01	None	Windows 2000				
3	SQL01	None	Windows 2000				
3	EXE01	None	Windows 2000				
3	POW01	None	Windows 2000				
5	Ann's PC	Floppy disk	Windows 2000				
5	John's PC	Floppy disk	Windows 2000				
6	SRV1	DLT Tape	Windows 2000	Intel Xeon 2.4	2000	75	80
6	SRV2	DLT Tape	Windows 2000	Dual Processor Pentium III 1.13	1000	96	80
8	Server 8	Other	Windows 2003	P4 2.8	1	640	
8	Server 5	Other	Windows 2000	DUAL XEON 2800	4	136	
8	Server 6	Other	Windows 2000	P2 400	512	18	
8	Server 8	Other	Windows 2003	P4 2.8	1	640	
8	Server 9	Other	Windows 2003	XEON 2400	2	110	
8	Server 12	Other	Windows 2003	XEON 2400	1	37	
8	Mail	Other	Windows NT	PRO 200	394	50	
8	Web	Other	Windows 2003	DUAL PRO 400	320	8	
8	CAD	Other	Windows 2000	P3 1400	512	68	
10	Secretary PC	Floppy disk	Windows 2000				
11	Desktop PC	Other	Windows 2000				
12	NT_fs02	DAT Tape	Windows NT				40
12	Linux	Other	Linux				no backup
13	Citrix1	Other	Windows 2000	Dell Poweredge 1400 PIII 800	516	42	Citrix Server software 1.8
13	Citrix2	DAT Tape	Windows 2000	Dell Poweredge 2500 PIII	1024	40	

				1133Mhz			
13	Navaho E-mail	Other	Linux	Sun Cobalt Raq550			
13	Navaho Firewall	Other	Linux	Sun Cobalt Raq550			
15	Desk PC	CD RW	Windows XP				
16	Jackies PC	CD RW	Windows XP				
17	AS400	Other	Other		512	60	IBM special (OS400)
17	ICL001	Other	Windows 2000	2Ghz	1500	20	Backup AIT
19	MAUKNT1	DAT Tape	Windows 2003			60	Raid 5 DDS4PDC
19	MAUKNT3	DAT Tape	Windows 2003			120	Raid 1/0 DDS 72
19	MAUKNT2	Other	Windows NT			60	Raid 5
20	Engima	DAT Tape	Windows NT	2 x 800 P3	512	20	
21	Desktop PC	Other	Windows 98				
21	Office 1	Other	Windows 98				
22	NAS	DAT Tape	NETWARE	Pentium 2.4Ghz	512		
22	Verity	DAT Tape	NETWARE	Pentium 3 - 1Ghz	512		
22	Retrospect	Hard disk	Windows 98	AMD Duron 1.2Ghz	248		
22	N_Seals	Other	NETWARE	Pentium - 180 Mhz	64		
22	Accounts	Other	NETWARE	Pentium III - 450 Mhz	128		
23	Newcastle5	DLT Tape	Windows 2003	Dual Pentium XEON 2.8	4	120	
23	Newcastle1	DLT Tape	Windows NT				
23	Newcastle3	DLT Tape	Windows 2000				IBM Super DLT
23	Newcastle2	DLT Tape	Windows NT				
23	Newcastle4	Other	Windows 2000			120	
23	Newcastle6	DLT Tape	Windows 2003				
23	Radford1	DAT Tape	AIX				
24	Dave	CD RW	Windows XP				
24	Lynne	Floppy disk	Windows XP				
25	Newcastle	DAT Tape	Windows NT				
26	Desktop PC	CD RW	Windows XP				and Floppy
29	Sage Server	DAT Tape	Windows 2000				
29	Payroll (Claire Green)	Other	Windows XP				
30	Kay's PC	CD RW	Windows XP				

30	Glen	CD RW	Windows XP				
30	Graeme	CD RW	Windows XP				
30	Glen Dell	Hard disk	Windows XP				
31	Dell 6400	Hard disk	Windows 2000	Dual Xeon 1500mhz	2	120	Back up to external hard disk using back up exec
31	Dell 2400 File	Hard disk	Windows 2000	Dual Xeon 2GHZ	2	200	
31	Dell 4800 File	Hard disk	Windows 2000	Dual PIII 1GHZ	1	200	
31	Dell 2400 DC	DAT Tape	Windows NT	Dual PIII 500MHZ	512	20	
31	Dell 4800 File	None	Windows 2000	Dual PIII	1	100	

Table 17: ICT Survey: Server Information

id	Software Type	name	number of users	Server OS	comment
1	ERP	SAGE Line 50	3	Windows 2000	Just for Wages and full accounts
1	Antivirus Software	Symantec Antivirus		Windows XP	Version 9
1	Backup Software	Backup Exec.	1	Windows 2000	Future DEF Backup Server, Version 9.1
1	Email Server	VPOP	10	Windows 2000	Version 2.0j
1	Firewall Software	Winroute	10	Windows XP	Version 6.04
1	Web Server	Microsoft IIS		Windows 2000	Version 5.0
1	Database Server	MS SQL Server 2000	10	Windows 2000	
1	Grafic Suite	Corel Draw	3	Windows XP	Version 12
1	Web Design	Macromedia DreamWeaver 2004	1	Windows XP	
1	Other	User Files	3	Windows XP	Personal User Files for DEF staff and public files
1	MS Office	Ms Office XP	5	Windows XP	
3	ERP	Syteline	70 (35 concurrent)	Windows 2000	V6.10; Progress Database 9.2
3	MS Office	MS Office 97	95	Windows 2000	
3	Antivirus Software	Inoculan	95	Other	
3	Backup Software	Veritas BackupExec	1	Windows 2000	V 8.0
3	CAD Software	Autodesk Mechanical Desktop 6	5	Other	
3	Firewall Software	GFI ISA	1	Windows 2000	
3	Database Server	MS SQL 7	5	Windows 2000	
3	Other	Time and Attendence	3	Windows 2000	SQL based
3	Other	Pegasus		Other	Accounting
3	Email Server	Office Talk	75	Windows 2000	

id	Software Type	name	number of users	Server OS	comment
5	ERP	Sage	1	Windows 2000	for Invoicing
5	MS Word	Word	2	Windows 2000	
5	MS Excel	Excel	2	Windows 2000	
5	CAD Software	BobCad17	1	Windows 2000	
5	FAX Server	WinfaxPro	1	Windows 2000	
5	Antivirus Software	mcafee	1	Windows 2000	
6	MS Office	Ms Office	24	Windows 98	Version 97
6	ERP	Sage Line 100	12	Windows 2000	
6	ERP	Payroll	2	Windows 2000	
6	Antivirus Software	McAffee Total Virus Defence	35	Windows 98	
6	Backup Software	Veritas BackupExec	2	Windows 2000	Version 8.6
6	CAD Software	AutoCad	2	Windows 2000	Version 2002
6	CAD Software	Autodesk Inventor	1	Windows 2000	Version 6.3
6	Email Server	MS Exchange	1	Windows 2000	Version 2000
6	Database Server	Superbase	5	Windows 2000	Version 2001, Own Manufacturing Software
8	Backup Software	Retrospect	1	Windows 2003	
8	MS Office	Microsoft Office	106	Windows 2000	
8	ERP	Avante	106	Windows 2000	
8	Antivirus Software		106	Windows 2000	
8	CAD Software	Autocad	14	Windows 2000	

id	Software Type	name	number of users	Server OS	comment
8	Other	Payroll	10	Windows 2000	
8	Email Server	Mail	106	Windows NT	
8	Other	Adobe Reader	20	Windows 2000	
10	MS Office	MS Office	2	Windows XP	Secretary on Windows 2000
10	ERP	Sage Payroll	1	Windows 2000	
10	Antivirus Software	AntiVir	2	Windows XP	
11	ERP	Sage	1	Windows 2000	Wages package
11	MS Word	Word	1	Windows 2000	
11	MS Excel	Excel	1	Windows 2000	
11	Other	Spam Package	1	Windows 2000	
12	MS Office	MS Office	25	Other	MIXED OS
12	ERP	EFACS	7	Windows NT	
12	ERP	Sage Payroll	1	Windows XP	
12	CAD Software	JET CAM	2	Other	CNC CODE
12	CAD Software	Autocad 98 Light	1	Other	
12	CAD Software	PM 2000	1	Other	CNC Code for profilers
12	CAD Software	Peps Cad		Other	CNC machining code
12	Antivirus Software	McAffee	25	Other	Virusscan ASaP
12	Backup Software	Yosemite Tapeware	1	Windows NT	
12	Email Server	Linux		Linux	customised by griffin
12	FAX Server	FaxNow		Windows NT	
12	Database Server	MS SQL 7.0		Other	replacement planned 2003
12	Database Server	Crystal Reports SEA GATE32		Other	to be replaced by cystal 9.0

id	Software Type	name	number of users	Server OS	comment
13	MS Word	MS Word	-20	Windows 2000	
13	MS Excel	MS Excel	-10	Windows 2000	
13	CAD Software	Autocad LT 2000		Windows 2000	
13	Email Server	Navaho	25+	Linux	Hardware (Sun Cobalt) owned by Electrak. Software on annual lease from Navaho.co.uk who provide backup and maintenance
13	Firewall Software	Navaho		Linux	See Email server
13	ERP	VIP	20	Windows 2000	Tailor made system written in house
13	Other	Opera	3	Windows 2000	Accounting package
13	Other	Timeware		Windows 2000	Time Recording system for factory workers payroll
15	Development	Visual C/C++	1	Windows XP	
15	Antivirus Software	McAffee	4	Windows XP	
15	Antivirus Software	Norton	1	Windows XP	
15	CAD Software	Turbo Cad	1	Windows XP	
15	Other	PDF Converter	1	Windows XP	
16	MS Office	MS Office	3	Windows XP	
16	Antivirus Software	Norton Antivirus	3	Windows XP	
16	CAD Software	Autocad 200 LT	1	Windows XP	
16	ERP	Sage Payroll	1	Windows XP	
16	ERP	Sage Accounts	1	Other	
17	MS Office	Ms Office	60	Windows 2000	or Win XP
17	Backup Software	Veritas Backup Exec	1	Windows 2000	Version 9
17	Email Server	MS Exchange	120	Windows 2000	

id	Software Type	name	number of users	Server OS	comment
17	Antivirus Software	Nod32 + Message Labs	120	Windows 2000	
17	ERP	Geac System 21	40	Windows 2000	
19	MS Office	MS Office	20	Other	From 2000 to 2003
19	ERP	Pegasus Opera	10	Windows 2000	Finalcial and Job Shop Controlling
19	Antivirus Software	McAffee	25	Other	Small BUsiness Edition Total Virus Defence
19	Backup Software	Standard Windows Backup		Other	
19	Email Server	MS Exchange 2003 Standard	20	Windows 2003	
19	FAX Server	GFI Faxmaker	15	Windows 2003	
19	Development	Lab View	1	Other	Machine Control
19	Other	MS Terminal Services	5	Windows 2000	Application Mode
20	ERP	Sage Manufacturing and Fiancial Controller V10	3 for manufacturing, 3 for FNC	Windows XP	
20	MS Office	Office XP Professional	9	Windows XP	
20	Antivirus Software	Sophos Anti-virus	10	Windows XP	
20	Backup Software	HP Surestore	1	Windows XP	
20	CAD Software	Solidworks 2005	1	Windows XP	
20	Firewall Software	Smoothwall	1	Linux	
21	MS Word	Word	3	Windows 98	
21	CAD Software	Autocad 2000i LT	3	Windows 98	
21	CAD Software	Wish list	1	Windows 2000	CSC;TEDDS, Integer;Superstress
22	Antivirus Software	C012	1	Windows XP	Norton Systemworks 2005
22	CAD Software	2000	2	Windows 98	AutoCAD Mechanical + AutoCAD 2000
22	CAD Software	14	2	Windows 98	AutoCAD Mechanical 3 with AutoCAD Release 14

id	Software Type	name	number of users	Server OS	comment
22	MS Office		75	Windows 98	Office 97 - 2000
22	Antivirus Software	Sophos	1	Windows 98	Sophos Antivirus
22	Backup Software	Retrospect	75	Windows 98	
22	Backup Software	Arcserve	1	NETWARE	
22	Backup Software	Backup Exec	1	NETWARE	
22	Email Server	VPop3	75	Windows 98	
23	ERP	MFG Pro	64	AIX	V 91c, SP5
23	ERP	Payroll Kempay	5	Windows NT	
23	ERP	Time & Attendence Smart Systems	2	Windows NT	V8.5
23	MS Office	MS Office	120	Windows XP	60 PC – XP, 60 PC - 2000
23	Antivirus Software	Norton Antivirus Corporate Edition	120	Windows XP	V8
23	Backup Software	Abckuo Exec	4	Windows NT	V 7.3 – NT, V 8.6 – NT, v 9.1 - 2000&2003
23	Email Server	MS Exchange 2003	120	Windows 2003	
23	Database Server	SQL Server 7	8	Windows NT	
23	Database Server	Progress	5	Windows NT	v 9, Payroll
23	Database Server	Progress	64	AIX	V9, MFG Pro
23	Database Server	Sybase	2	Windows NT	Time & attendance
23	CAD Software	Autodesk Inventor	8	Windows 2003	v 9
23	Firewall Software	Sonicwall		Other	Hardware
23	Grafic Suite	Cinema 4D	2	Windows XP	V8&9
23	Grafic Suite	Adobe Suite	3	Windows XP	
23	Grafic Suite	Quark Xpress	3	Windows XP	V 4&6
23	Other	Workflow eWork	8	Other	v5 brWeb based IIS, Engineering Change, SQL

id	Software Type	name	number of users	Server OS	comment
24	MS Office	MS Office	2	Windows XP	
24	ERP	Sage Line 50	1	Windows XP	
24	Antivirus Software	Norton Antivirus	1	Windows XP	V 2004
25	MS Office	MS Office	14	Windows 2000	
25	ERP	BPCS	12	Windows NT	MRP II
25	ERP	MSS	5	Windows NT	Sales
25	Antivirus Software	MCAffee Virusscan	13	Windows 2000	
25	Backup Software	???	1	Windows NT	
25	Database Server	OPERA	1	Windows NT	
26	ERP	Sage Account & Payroll	1	Windows XP	
26	Antivirus Software	McAffee	1	Windows XP	
26	CAD Software	AutoSketch	1	Other	
26	Other	MS Publisher	1	Windows XP	
29	MS Office	MS Office	16	Windows XP	
29	Antivirus Software	Symantec Antivirus Client	16	Windows XP	
29	Backup Software	Windows Backup		Windows 2000	
29	CAD Software	Autocad	1 max 2	Windows XP	Intention for the future
29	Grafic Suite	MS Publisher	16	Windows XP	
29	ERP	Sage Accounts	10	Windows 2000	
29	ERP	Sage Payroll	1	Windows XP	
30	MS Office	MS Office	6	Windows XP	
30	ERP	Sage Sovereign	4	Windows XP	
30	Antivirus Software	Symantec & Panda	6	Windows XP	Symantec Small Business Edition 9.0

id	Software Type	name	number of users	Server OS	comment
30	Backup Software	?	1	Windows XP	
30	CAD Software	Solid Works	6	Windows XP	Viewer only
30	Grafic Suite	Adobe Photoshop	1	Windows XP	
31	MS Office	Ms Office	100	Windows 2000	OS: Win2000 or XP
31	ERP	Sage Line 100	12	Windows NT	
31	Antivirus Software	Symantec AV Corporate	100	Other	OS: Mix
31	Backup Software	Veritas Backup Exec	6	Other	Mix Versions, OS: mix
31	CAD Software	Radan	3	Other	
31	CAD Software	Solid Works	5	Other	V 2005
31	Email Server	MS Exchange	100	Other	V 5.5
31	Firewall Software	Sonicwall		Other	2x
31	Firewall Software	Inty		Other	
31	Database Server	MS Sqo Server 2000	3	Other	Sage Line 500
31	Grafic Suite	Adobe Photoshop	2	Other	
31	Development	MS Access	5	Other	
31	ERP	Sage Payroll	5	Other	
31	ERP	TA PRO	4	Other	
31	Other	User Files	100	Other	

Table 18: ICT Survey: Software Information

Appendix D: Collaborative purchasing prototype software database

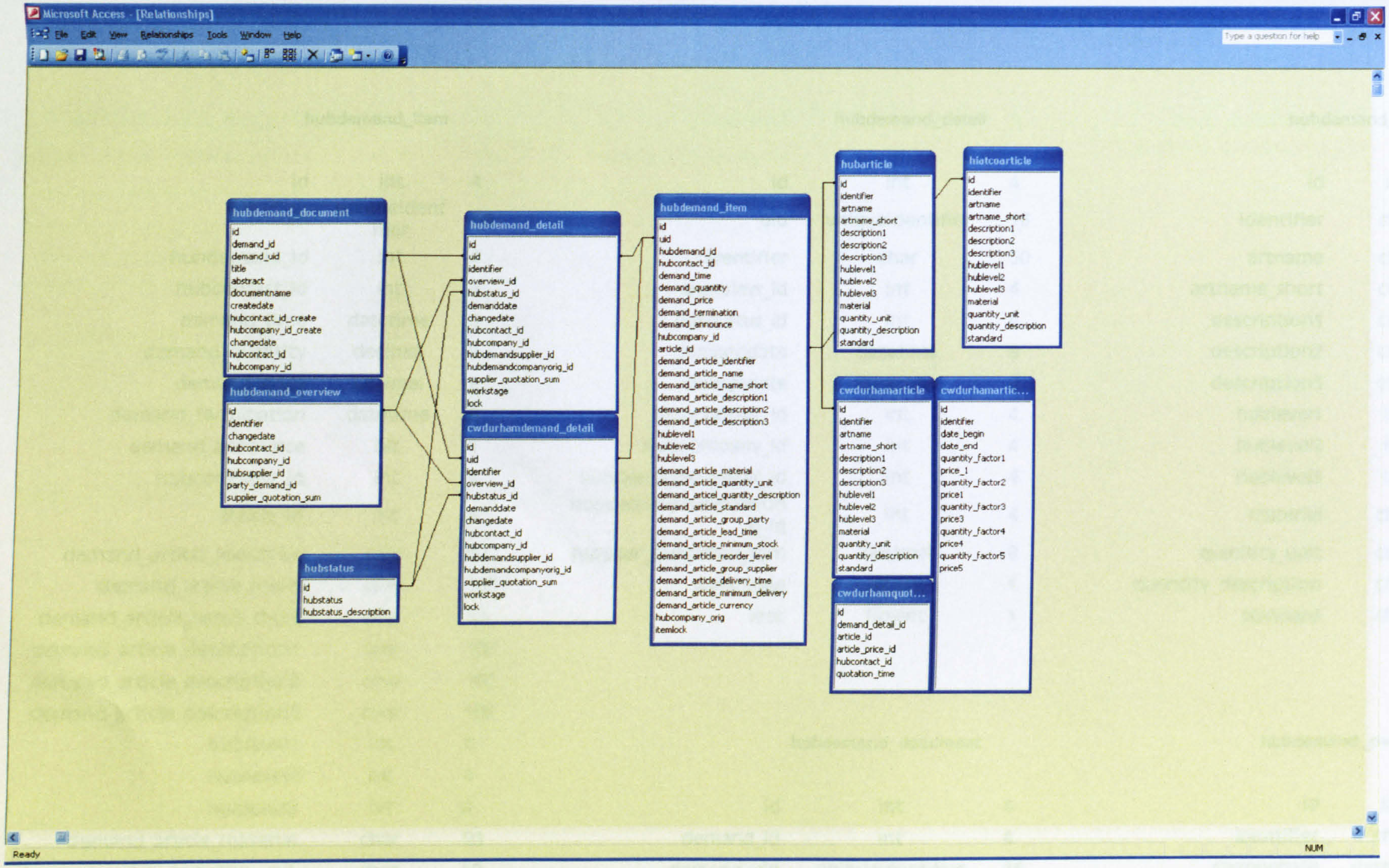


Figure 72: Collaborative procurement: hub demand management

hubdemand_item

id	int	4
uid	uniqueidentifier	16
hubdemand_id	int	4
hubcontact_id	int	4
demand_time	datetime	8
demand_quantity	decimal	9
demand_price	decimal	9
demand_termination	datetime	8
demand_announce	bit	1
hubcompany_id	int	4
article_id	int	4
demand_article_identifier	char	50
demand_article_name	char	100
demand_article_name_short	char	10
demand_article_description1	char	100
demand_article_description2	char	100
demand_article_description3	char	100
hublevel1	int	4
hublevel2	int	4
hublevel3	int	4
demand_article_material	char	50
demand_article_quantity_unit	char	50
demand_articel_quantity_description	char	50
demand_article_standard	char	50
demand_article_group_party	char	50

hubdemand_detail

id	int	4
uid	uniqueidentifier	16
identifier	char	50
overview_id	int	4
hubstatus_id	int	4
demanddate	datetime	8
changedate	datetime	8
hubcontact_id	int	4
hubcompany_id	int	4
hubdemandsupplier_id	int	4
hubdemandcompanyorig_id	int	4
supplier_quotation_sum	decimal	9
workstage	tinyint	1
lock	tinyint	1

hubdemand_article

id	int	4
identifier	char	50
artname	char	100
artname_short	char	10
description1	char	100
description2	char	100
description3	char	100
hublevel1	int	4
hublevel2	int	4
hublevel3	int	4
material	char	50
quantity_unit	char	50
quantity_description	char	50
standard	char	50

hubdemand_document

id	int	4
demand_id	int	4
demand_uid	uniqueidentifier	16
title	varchar	250
abstract	text	16
documentname	varchar	250

hubdemand_overview

id	int	4
identifier	char	50
changedate	datetime	8
hubcontact_id	int	4
hubcompany_id	int	4
hubsupplier_id	int	4

demand_article_lead_time	char	50	createdate	datetime	8	party_demand_id	char	50
demand_article_minimum_stock	char	50	hubcontact_id_create	int	4	supplier_quotation_sum	int	4
demand_article_reorder_level	char	50	hubcompany_id_create	int	4			
demand_article_group_supplier	char	50	changedate	datetime	8			
demand_article_delivery_time	char	50	hubcontact_id	int	4			
demand_article_minimum_delivery	char	50	hubcompany_id	int	4			
demand_article_currency	char	50						
hubcompany_orig	int	4						
itemlock	int	4						

Table 19: Collaborative procurement: hub demand management

hubstatus

id	int	4
hubstatus	char	50
hubstatus_description	char	50

values

1	SCHEDULE	planed, but not determined
2	RFQ	determined with quantity, date
3	QUOTE	during negotiating process
4	ORDER	submited an order
5	SUPPLY	delivery on its way
6	INVOICE	payment on its way

cwdurham_article_price

id	int	4
identifier	char	50
date_begin	datetime	8
date_end	datetime	8
quantity_factor1	char	50
price_1	char	50
quantity_factor2	char	50
price1	char	50
quantity_factor3	char	50
price3	char	50
quantity_factor4	char	50
price4	char	50
quantity_factor5	char	50
price5	char	50

cwdurham_quotation

id	int	4
demand_detail_id	int	4
article_id	int	4
article_price_id	int	4
hubcontact_id	int	4
quotation_time	datetime	8

Table 20: Collaborative procurement: hub demand management

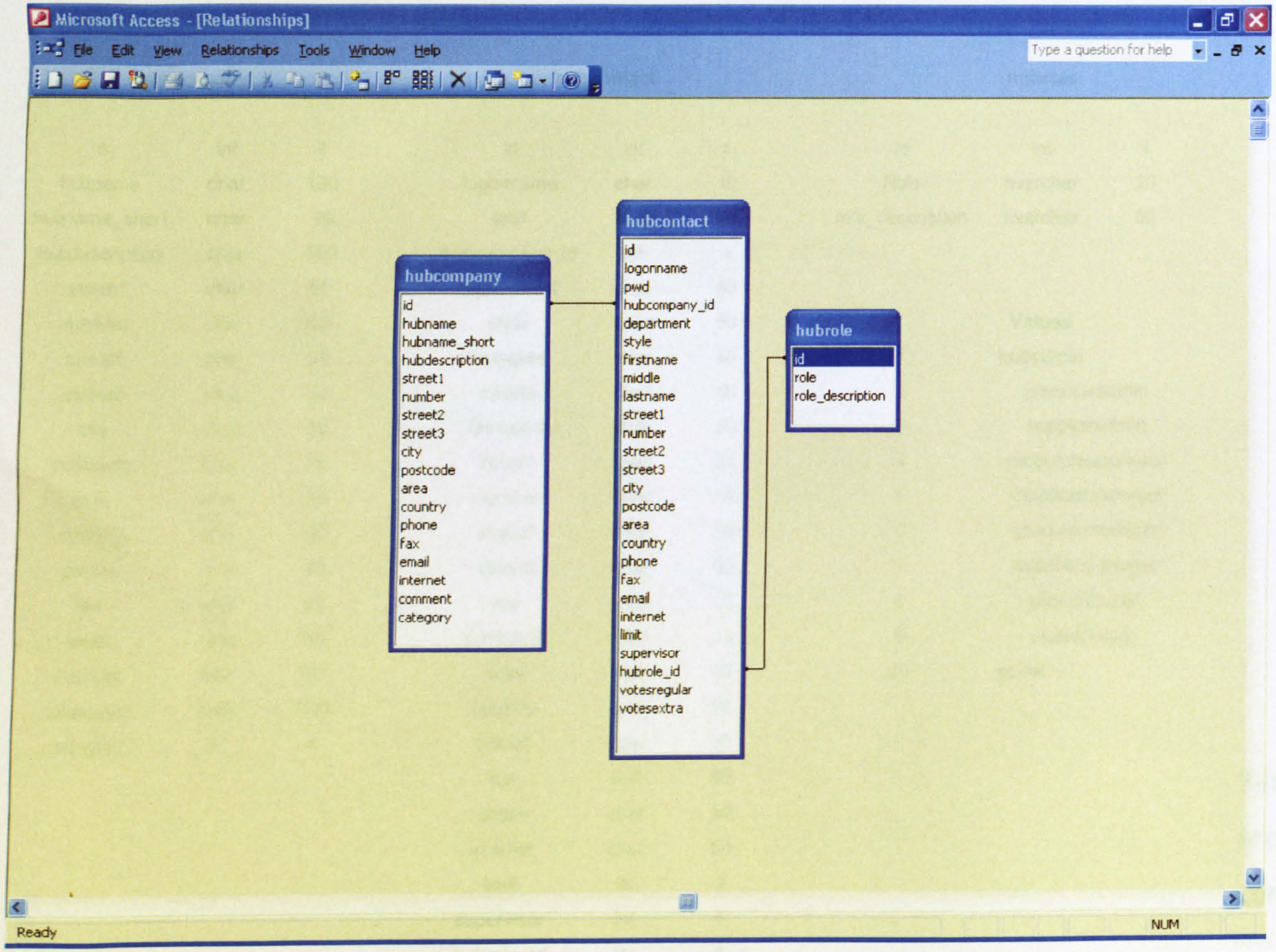


Figure 73: Collaborative procurement: companies – contacts - roles

hubcompany

id	int	4
hubname	char	100
hubname_short	char	10
hubdescription	char	500
street1	char	50
number	char	50
street2	char	50
street3	char	50
city	char	50
postcode	char	50
area	char	50
country	char	50
phone	char	50
fax	char	50
email	char	50
internet	char	50
comment	char	200
category	int	4

hubcontact

id	int	4
logonname	char	10
pwd	char	20
hubcompany_id	int	4
department	char	50
style	char	50
firstname	char	50
middle	char	50
lastname	char	50
street1	char	50
number	char	10
street2	char	50
street3	char	50
city	char	50
postcode	char	10
area	char	50
country	char	50
phone	char	50
fax	char	50
email	char	50
internet	char	50
limit	int	4
supervisor	int	4
hubrole_id	int	4
votesregular	int	4
votesextra	int	4

hubrole

Id	int	4
Role	nvarchar	20
role_description	nvarchar	50

Values

1	hubadmin
2	procureradmin
3	supplieradmin
4	procurersupervisor
5	suppliersupervisor
6	procurermanager
7	suppliermanager
8	procureruser
9	supplieruser
20	guest

Table 21: Collaborative procurement: companies – contacts - roles

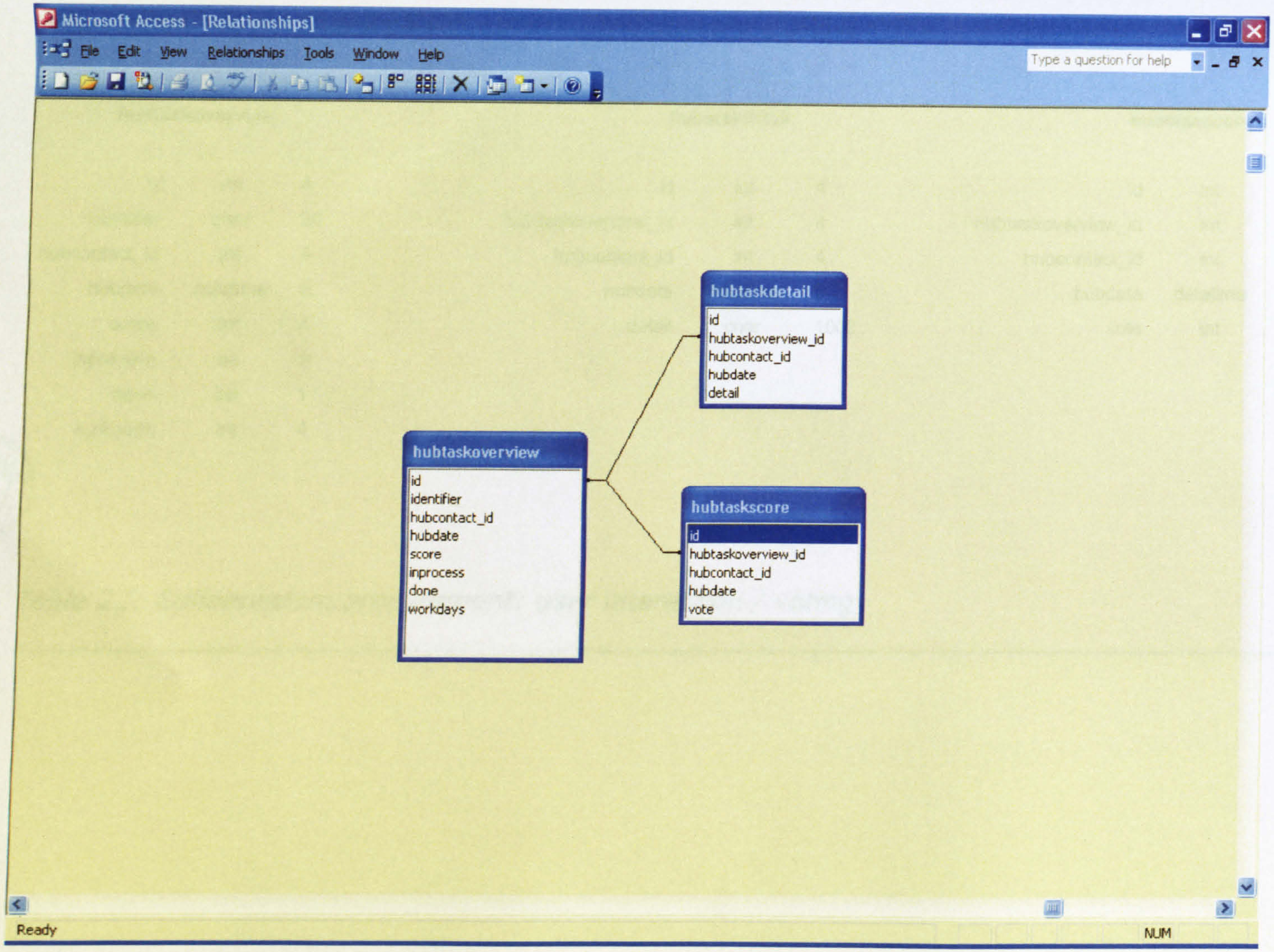


Figure 74: Collaborative procurement: user interaction / voting

hubtaskoverview

id	int	4
identifier	char	50
hubcontact_id	int	4
hubdate	datetime	8
score	int	4
inprocess	bit	1
done	bit	1
workdays	int	4

hubtaskdetail

id	int	4
hubtaskoverview_id	int	4
hubcontact_id	int	4
hubdate	datetime	8
detail	char	1000

hubtaskscore

id	int	4
hubtaskoverview_id	int	4
hubcontact_id	int	4
hubdate	datetime	8
vote	int	4

Table 22: Collaborative procurement: user interaction / voting